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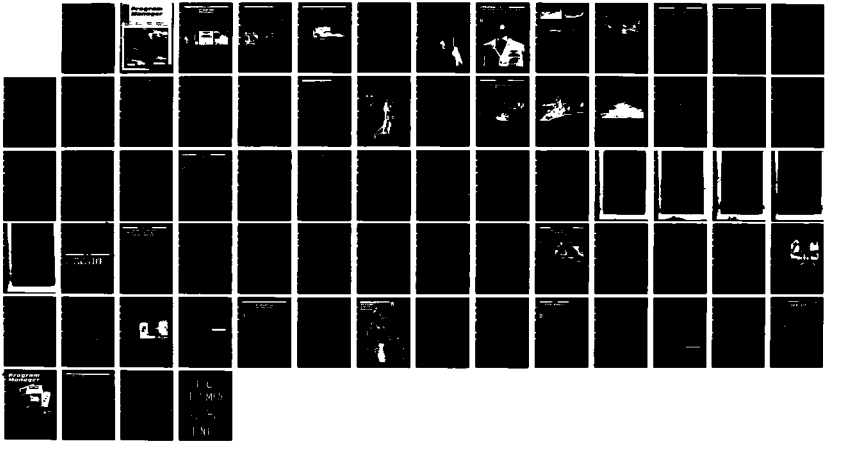

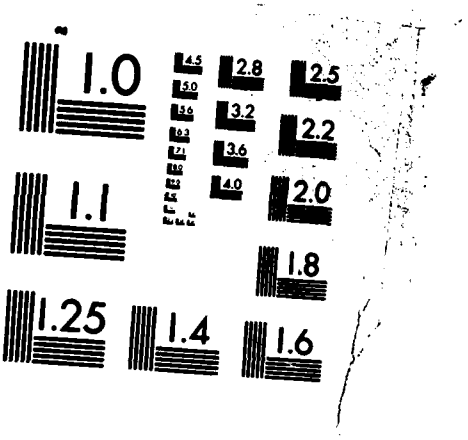

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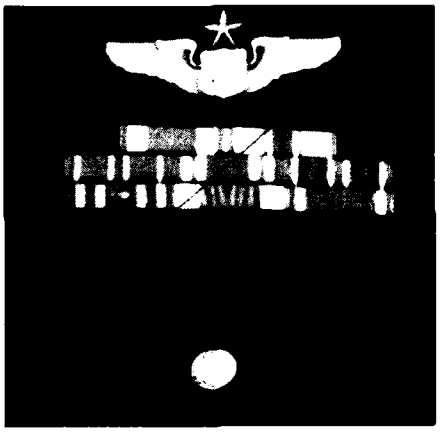

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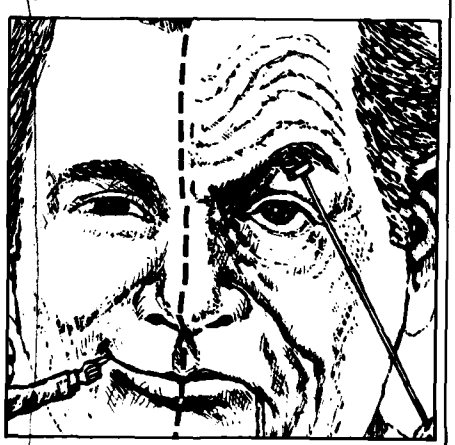
Cover: An M712 Copperhead cannon-launched, laser-guided projectile as it nears the target, an M47 medium tank, at White Sands Missile Range, N.M.



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Technology for the Tactical Air Forces

Lieutenant General Robert H. Reed, USAF

These remarks were prepared for delivery by Lieutenant General Reed at Tech Expo '85, Griffiss AFB, N.Y., the past August.

In discussing technology and its effects on any phase of our lives, we could talk for days and still not make a dent in the vast amount of knowledge that has been accumulating and continues to grow daily. The technological revolution we've been experiencing is aptly characterized as an explosion of information - - new ideas, concepts and methods have given us products on Monday that became obsolete on Friday. In addition, technological wonders don't surprise us anymore. We've become "technological sophisticates." If I were to tell you that the latest fashion fad—plastic quartz wrist watches of different colors and faces—are made by robots and sealed by lasers, you'd probably say to yourselves, "So what's new?"

Cellular car phones, refrigerators that make ice cream, and computers that understand spoken words would put our great-grandparents into shock, but they hardly phase us. Can you imagine the look on Orville Wright's face if he could take a ride in an F-15 or F-16?

There's no doubt that technology is a driving force in our society. It's improved the quality of our lives and expanded the boundaries of our world. And it has had a very dramatic effect on the Air Force. It's changed the way we train, fly and fight.

Have the wonders of technology benefitted the Air Force? I think the answer is obvious: we have the best Air Force in the world and technology has been a major factor in gaining this position.

F-15 and ASAT missile

We have the best Air Force in the world and technology has been a major factor in gaining this position.

The Quality Edge

I want to focus more specifically on the challenges technology holds for the tactical air forces. Perhaps more than any other part of our military forces, the tactical air forces have to operate at the forefront of applied technology. The enemy outnumbers us, and we count on our quality edge to make the difference between victory and defeat. And the quality edge we have does make a difference, as the Syrians found out in their meetings with Israeli F-15s and F-16s over the Bekaa Valley in 1982. When the dust had settled, the Syrians had far fewer Soviet-made airplanes in their inventory, and not a single Israeli F-15 or F-16 had been lost.

Time, of course, doesn't stand still, and there are new ideas, concepts and technological applications in the labs and on the drawing board that will permit us to perform far beyond even the advanced capabilities of our F-15s and F-16s. Our problem is to work within fiscal constraints and choose the best of competing ideas, yet still keep our forces ready to fight today. We have no choice but to maintain the effectiveness of present forces while we work to develop new capabilities we will need in the future.

This is where the tactical forces face a tough challenge, because on the priority list they presently fall behind modernizing our strategic forces, improving the readiness and sustainability of general purpose forces, and increasing airlift capability. This doesn't mean that we're ignoring the modernization of our tactical forces: in fact,

today over half our force is made up of modern F-15s, F-16s and A-10s. Five years ago the fighter force was composed primarily of older F-4s, A-7s and F-106s, so we are making progress—but not as much as we would like. Consequently, the leverage technology can give us to use the capabilities we have in a better way is very important.

Effective Battle Management

Let me explain what I mean by that last statement. Effective battle management is critical if we want to get the most effective use of the tactical air forces. We have to know the disposition and movement of enemy air and land forces to counter them effectively. This knowledge allows us to coordinate our actions so that we move at the time and place where the enemy is most vulnerable. This capability is particularly important against an enemy who outnumbers us. The need to use our limited assets for different missions at different locations throughout the theater makes effective force management very important.

Today we solve the battle management problem using capabilities inherent in our satellites, strategic reconnaissance aircraft, and the airborne warning and control system. These systems give us wide area coverage of the battle area and help us to employ our forces against the threat, but these are first-generation systems and we have to do better. The next generation of sensors will give us much better tools to use in getting the job done. With them, we will be able to detect and categorize ground-force movements far behind enemy lines. In the past, our knowledge of the enemy's disposition of forces in the rear area has been scant. It took great amounts of time and inputs from a multitude of sources to piece together a picture. The result was inconsistency and lack of responsiveness, which resulted in missed opportunities. Now, new technologies hold the promise of overcoming these problems, allowing us to employ our forces more effectively.

The technologies I'm talking about include wide-area sensors, such as the Joint Surveillance Target Attack Radar System (JSTARS), which will be able to detect and track theater-wide movement of ground forces in the enemy's rear. The JSTARS is now in full-scale development and will be available for a European field test demonstration in 1989. Another is the Precision Location Strike System (PLSS). The PLSS is designed to locate enemy defenses in near real-time and all weather conditions and allow attack from standoff ranges by both ground and airborne weapons systems. The PLSS is scheduled to become operational in the late 1980s.

Additional systems that will improve our capability include digital computers with increased capacity and reduced processing time that can yield near real-time intelligence and targeting data; simulation facilities to improve the proficiency of those who analyze and direct the battle (USAFE's Warrior Preparation Center is one example); and rapid jam-resistant communications.

Improved Avionics, Munitions

What other effects is technology having on the tactical air forces? There's no doubt that it has increased the contribution of manned fighter aircraft to our overall combat posture by permitting development of improved avionics and munitions. For example, in meeting the air-to-air threat, pulse Doppler radars and heads-up displays have helped by increasing the pilot's ability to detect incoming targets and employ his weapons.

In the air-to-surface arena, target acquisition is still the most difficult part of the mission. In the past, little progress had been made in improving the pilot's ability to acquire mobile ground targets. But recent developments are changing this situation. Forward looking infrared (FLIR) technology and high resolution synthetic aperture radar technology hold the promise for systems that will make the task of finding and attacking mobile targets much easier. In addition, these same technologies should provide a most important element for our air forces—the ability to operate at night and in adverse weather. Soon, aircraft like the F-15E dual-role fighter that is in development will be able to operate around-the-clock with high effectiveness. When this happens, we will be more able to successfully prosecute the air-land battle.

■ *Lieutenant General Reed is the assistant vice chief of staff, U.S. Air Force.*

Turning to munitions, the value of precision-guided weapons was clearly shown in Vietnam when eight F-4s with laser-guided bombs destroyed the Than Hoa Bridge on a single mission. This was after 873 unsuccessful sorties with unguided ordnance. While relatively few new types of munitions have been fielded since Vietnam, this is beginning to change. Today, second-generation precision-guided weapons are coming into the inventory and we are working to match the accuracy and lethality of these weapons against different types of targets.

Some promising developments include air-to-surface munitions with warheads tailored to specific targets. Some examples are the Direct Airfield Attack Combined Munition (DAACM), the Sensor Fired Weapon (SFW) and the Gator mine. The DAACM employs a ballistic kinetic energy penetrator submunition to crater runway surfaces. The SFW is an anti-armor munition that will provide multiple armor target kills per aircraft pass. And Gator is a dispensable mine used to channelize the enemy and make him easier for our ground forces to handle.

We are also procuring launch-and-leave precision-guided munitions which can be dropped from standoff distances, reducing aircraft exposure to enemy defenses.

Increased Survivability

Another benefit of technology for conventional air forces has been to increase the survivability of manned aircraft. The Soviet surface-to-air defense network is formidable, but is vulnerable in several ways: It depends on a netted array of radars and communications; its radar-controlled missiles and guns give off energy, signalling their locations; and surface defenses are generally immobile as compared to the aircraft they oppose. Technology and tactics can work on these vulnerabilities and degrade their effectiveness. With the aid of technology, we can keep the air defense threat manageable.

Mature technologies that will help improve the survivability of aircraft are:

—Making aircraft hard to see on enemy radars

—Adaptable standoff and self-protection jamming

—Radar warning receivers that tell our

pilots when an enemy gunner has them in his sights
—Lethal suppression of defenses by specialized aircraft and drones
—And, self-protection weapons.

When all of this is put together—improved battle management, better aircraft avionics, modern munitions and improved survivability—it becomes obvious that technology is significantly improving the effectiveness of our tactical air forces and will continue to do so.

Reliability, Maintainability, Operability

What about the impact of technology on reliability, maintainability and operability? It seems as though each succeeding generation of weapons is more sophisticated. Some equate this ever-increasing sophistication with complex systems that are difficult and costly to maintain. But the facts don't bear this out. Modern electronic components are more reliable and less expensive than the vacuum-tube technology they replaced. It's interesting to note that today's air crews, using computer-aided delivery systems, can deliver weapons much more easily and accurately than crews of 20 years ago. And our current fighters are easier to maintain and less likely to malfunction than the aircraft they replaced. Finally, the redundancy made possible in modern electronics reduces failures.

We've made it a major goal to get as much reliability and maintainability built into our systems and equipment as we possibly can, because the future payoff is significant in terms of manpower, cost savings and operational availability. Let me illustrate. The F-15 requires only two-thirds the maintenance manhours per flying hour as the F-4 airplane it is replacing. The C-17 airlifter, when it comes into the force in the early 1990s, will require only one-third that of the C-5A. This means that in a combat situation we'll spend less time on maintenance and be able to achieve higher sortie rates. And fewer people will be required to keep the new systems in commission.

The same technology that brought us Pac-Man and the rest of the video games has given us quality training through use of flight simulators, threat simulators and task trainers that are so close to the real thing you can barely tell the difference. They don't take the place of actual flying hours, but they do help to make them count more.

Finally, technology is making it possible for cruise and ballistic missiles to accomplish many jobs very effectively. Accurate, self-contained guidance systems; terminal guidance sensors; and improved warhead lethality are changing the picture so that a mix of unmanned and manned systems will give us the opportunity to field a high-quality force.

Technology will continue to be a driving force in how we perform our mission. Near real-time intelligence, weapons with higher accuracy and lethality that can be used from standoff distances, high-speed computer aided command and control systems that link things together, and advanced aircraft are some of the technologies that will give us new approaches to the battle. Our qualitative edge will depend on how we develop these technologies and use them.

Goha, a "wise fool" in Arab folklore, rode his donkey through the village facing backward. When the locals laughed at him, Goha said he was content to let the donkey take care of where he was going; he wanted to see where he'd been. And this is a very real problem we face when confronted with the dazzling array of technological wonders. In looking at our needs for the future, we must first take a close look at where we've been and how well we can do with what we have.■

UNIQUE OPPORTUNITY

The DSMC Reserve Program — Seven-Year Itch

Fred Bergert, CDR, USNR
Ronald L. Baker, LtCol, USAFR

Not all of the men and women in military uniform at the Defense Systems Management College (DSMC) are full-time active duty military personnel. A representative number of the military cadre are reserve officers on active duty for short periods of time lasting 2 weeks or so to broaden their acquisition management careers in the reserves.

Since 1979, the College has offered a unique opportunity for reservists of all military services to enhance their potential for career progression in program management and defense systems acquisition fields through participation in the DSMC Reserve Program. In so doing, DSMC has recognized the increasing support provided by the reserve forces to the overall capability of the military services.

Under the Total Force concept initiated by the Department of Defense in 1973, the United States increased the responsibilities of the reserve forces as partners with the active forces in carrying out national security strategy. During the ensuing period, the reserve forces have experienced a substantial increase in the extent to which they contribute to the overall defense effort. The following are examples of specific areas in which the reserve forces are presently contributing to their respective services.

Army. The guard and reserve constitute 38 percent of the divisional forces, 67 percent of the tactical support forces and 100 percent of the training divisions and brigades. The army reserve contributes a critical number of engineer, ordnance, medical, and transportation units to the U.S. Central Command (CENTCOM), one of the nation's most combat-ready fighting commands.

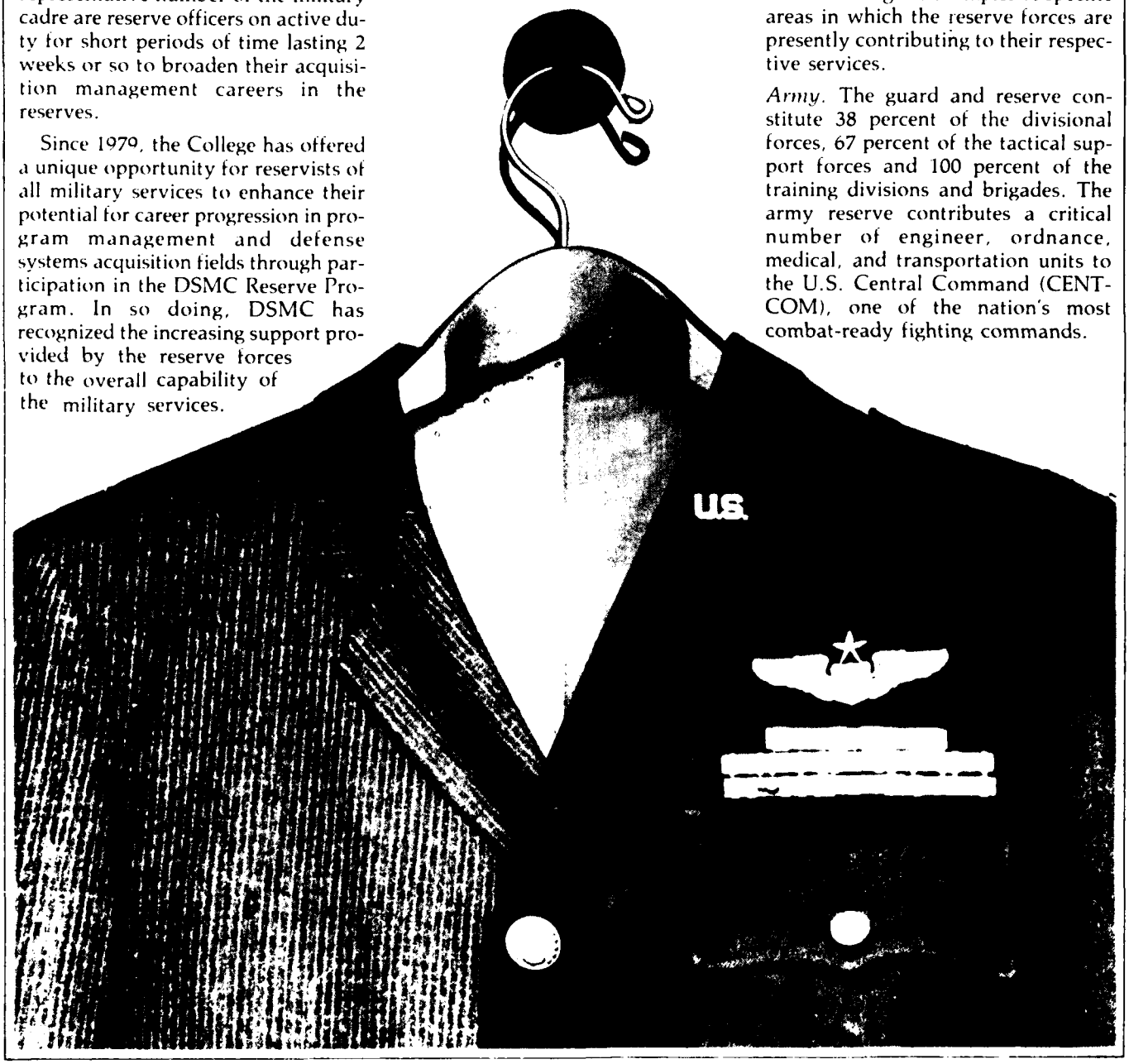
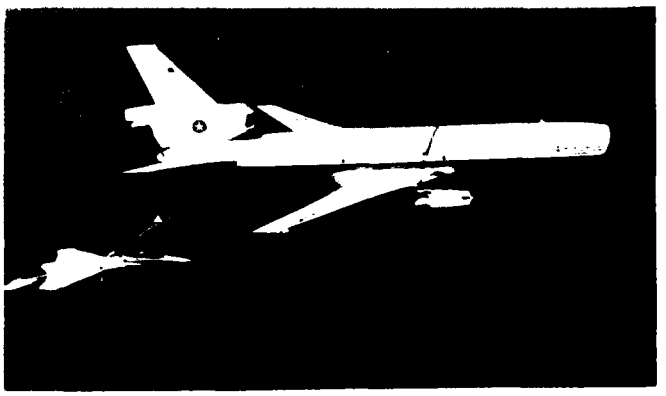


Photo courtesy of McDonnell Douglas



KC-10

C-141 C-5 Minesweeper

Air Force. The Air Force Reserve provides about 50 percent of the strategic airlift crews for the C-141 and C-5 aircraft. In addition, present plans call for the Air Force Reserve to furnish 50 percent of the crews for the KC-10 aerial refueling tankers. Also, when the new C-17 aircraft begins operations with the Air Force in 1991, a significant number of these aircraft coming off the production line are planned for assignment to the Air Guard and Reserve.

Navy. The Navy Reserve provides the Navy with 14 percent (2 carrier air wings) of its carrier air capability, 86 percent of the minesweepers and 35 percent of its patrol aircraft. Naval Reserve P-3 aircraft fly daily maritime patrol missions with their active duty counterparts. Under the horizontal integration presently being implemented in the Naval Reserve, new aircraft such as the F/A-18 Hornet are being introduced into reserve units at the same time active-force units receive the new aircraft.

Marine Corps. The Marine Corps Reserve provides 25 percent of the Marine Corps' total land and air capabilities. By way of specific examples, the Marine Corps Reserve provides, within the Marine Corps, 29 percent of the observation aircraft, 34 percent of the light attack aircraft, and 33 percent of the antiaircraft missile battalions. In addition to the foregoing, each military service has a significant number of reserve officers dedicated to supporting their respective services in the program management and acquisition areas.

The purpose of the DSMC Reserve Program is to provide training and education in the field of defense management and acquisition for reserve officers of all military services. In this way, DSMC seeks to fulfill its overall mission so far as the reserve community is concerned. This task may be accomplished through designation of the individual reserve officer as one of the following during his active duty period:

—Academic Associate in support of a faculty member

—Research Associate in support of a research project involving management and acquisition concepts and methods

—Student enrolled in a course offered at DSMC.

The scope of the various reserve assignments is intended to benefit the individual reservist as well as DSMC, while also upgrading the overall capability of the reserve forces in the field of acquisition and program management.

In addition to offering short periods of active duty for reserve officers at the main campus at Fort Belvoir, Va., DSMC has the capability for providing training for reserve officers at its regional centers located in Huntsville, Los Angeles, St. Louis, and Boston.

Since the inception of the DSMC Reserve Program in 1979, more than 450 reserve officers have performed training duty at DSMC. During such training duty, the reserve officer is exposed to the latest thinking in system acquisition management and has the opportunity to contribute to the development and formulation of concepts that will form the cutting edge of future defense acquisition policy. These opportunities include such research projects as the Program Manager's Support System (PMSS) which envisions the use of a small computer system to allow a program

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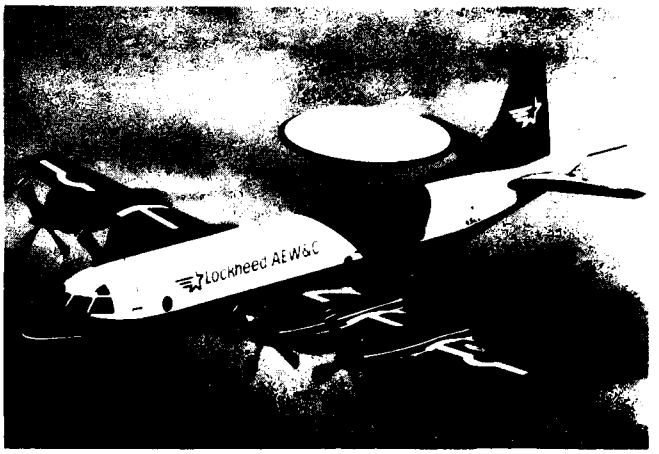
■ *Mr. Bergert is a commander in the Naval Reserve. He is assigned to Headquarters Naval Air Systems Command. Mr. Baker, a professor at DSMC, is a lieutenant colonel in the Air Force Reserve and DSMC director of reserve programs*

When the C-17 begins operations with the Air Force in 1991, it will also see duty with the Air Guard and Reserve. This is an example of how the needs of the Guard and Reserve are included in early acquisition and planning. Of the 210 C-17s to be built, 48 will be dedicated to Guard and Reserve units across the country.

P-3 Orion



manager to ask "what if...?" and "should I...?" questions and to generate alternative courses of action for consideration.

It has been found that the reserve officers bring to DSMC a wealth of experience and expertise that is often not available to the College through other sources. In their civilian jobs many reserve officers are actively involved in some phase of the acquisition and program managment process; thus, they bring to DSMC the industry viewpoint. In addition, there is an increasing opportunity for such reserve officers to participate actively in teaching one or more courses at DSMC.

The DSMC Reserve Program benefits DOD by providing challenging assignments that stimulate interest and enhance reserve programs. The program also serves as a vehicle for cross-fertilization of ideas among the services, thus providing a basis for long-term standardization of compatible facets of the acquisition process.

The DSMC Reserve Program is capable of utilizing reserve officers representing a variety of specialities: business, contracting, engineering, financial, legal, manufacturing, software and others.

In the overall curricula presently offered at DSMC, the College is graduating about 2,500 students each year from its 20-week Program Management Course and the many short courses in policy, technical and business management offered both at Fort Belvoir and at regional centers. Further increases in activity at the College are forecast, particularly in view of (1) direction of the Army that all future program managers be graduates of the DSMC Program Management Course, and (2) the recent inauguration by the secretary of the navy of a new officer career program, the Material Professional (MP) program, for assignments in billets requiring management of systems acquisition. Current planning calls for approximately 100 of the Navy's flag officer billets to be filled by materiel professionals.

In his final World War II report as Army Chief of Staff, General George C. Marshall wrote to the secretary of war that "probably the most important mission of the regular Army is to provide the knowledge, the expert personnel, and the installations for training the citizen-soldier, upon whom, in my opinion, the future peace of the world largely depends."

More recently, in August 1982, Secretary of Defense Caspar W. Weinberger stated: "We can no longer consider reserve forces as merely forces in reserve....Instead, they have to be an integral part of the total force, both within the United States and within NATO. They have to be, and in fact are, a blending of the professionalism of the full-time soldier with the professionalism of the citizen-soldier. Only in that way can we achieve the military strength that is necessary to defend our freedom."

The DSMC has just such knowledge, personnel and installations to fulfill the concepts General Marshall had in mind. Thus, DSMC is squarely positioned to carry on the training needed by the reserve citizen-soldiers of today in the field of acquisition and program management.

After 7 years, a large number of the reserve force have satisfied their "itch" to train at DSMC. If you have a similar desire to follow in the footsteps of your contemporaries and bring your acquisition management skills up-to-date, please write to the Driector, DSMC Reserve Program, Research Department, Fort Belvoir, Virginia 22060-5426 for a brochure.■

SENATE VIEWPOINT

Improving the Effectiveness of Weapon System Acquisition

Rudolph B. Garrity

"For more than 2 years, the Senate Committee on Armed Services has been studying the organization and decision-making procedures in the Department of Defense and the Congress." This statement Oct. 1, 1985, began a series of six speeches from the Senate floor in which Sen. Barry Goldwater (R-Ariz.) and Sen. Sam Nunn (D-Ga.) combined to express concerns that the Congress and the Department of Defense (DOD) were not as effective as they should be in protecting our national security.

The senators have concluded that the DOD organization structure is fundamentally flawed, thereby contributing to DOD deficiencies in mission integration, joint-service perspective, unity of command, and quality of decision-making. The DOD preoccupation with programming and budgeting (managing inputs) rather than attention to strategic planning, requirements identification, and program execution (managing outputs) is also a major problem along with significant congressional micromanagement of DOD programs.

Many of the senators' conclusions were based on information provided in the Senate Staff Report to the Committee on Armed Services entitled "Defense Organization: The Need for Change," released Oct. 16, 1985. Before release, the report was reviewed and condensed by the Senate Task Force on Defense Organization (including Senators Goldwater and Nunn as co-chairmen, and Senators Cohen, Quayle, Wilson, Gramm, Bingaman, Levin, and Kennedy) and military experts outside of DOD. The president's Blue Ribbon Commission on Defense Management (reference *Program Manager Magazine*, September-October 1985) also was briefed on results of the study and will, presumably, consider the report's recommendations with their own findings.

Specific recommendations in the report having direct impact on the weapon system acquisition and support process include:

—Create mission-oriented organizations in the Office of the Secretary of Defense (OSD).
—Strengthen the authority, stature, and support of joint organizations, particularly the Office of the Joint Chiefs of Staff (OJCS) and united commands.
—Improve military education to gain multiservice perspective and greater commitment to DOD-wide requirements.
—Strengthen representation of the JCS and unified commanders in the resource allocation process.
—Strengthen the influence of the secretary of defense within DOD and ensure that senior civilian authorities be informed of all legitimate alternatives.
—Diminish DOD's predominant focus on programming and budgeting.
—Improve the quality of DOD management information systems and DOD's ability to evaluate critically its own performance.

The senate staff's report has stirred controversy regarding usefulness of its recommendations. Additional issue focus and debate can be expected as the president's Blue Ribbon Commission submits its procurement report planned for February 1986, and its non-procurement reports planned for March and June 1986. The conjunction of these efforts, with management initiatives already taken within DOD, should provide the most comprehensive appraisal of congressional and DOD national defense management in many years. Congressional and DOD negotiations on which changes are essential will likely result in specific 1986 congressional legislation seeking to improve both the congressional oversight process and the organization and operational procedures within DOD.

If it is determined that most of the senate staff's recommendations are worthy of implementation, benefits likely to accrue to the acquisition management community would include:

—Clearer understanding of respective organizational responsibilities and authority.
—Improved channels of communication and more expeditious program coordination.
—Greater support for joint operations and acuqisitions resulting in improved mission integration.
—Greater participation by line managers in requirements definition and program priorities.
—Increased commonality and interoperability of inter-service weapon systems.
—Increased agreement on system minimum essential requirements.
—Better estimates of program resource requirements and stability of program funding.
—Improved, more timely decision-making based on clearly defined alternatives.
—Decreased congressional micromanagement of DOD programs.
—Improved sense of purpose, direction, and stability within DOD and among its contractors.

For weapon system acquisitiion and support professioals, 1986 may be the year that significant action is taken toward correcting systemic congressional and DOD deficiencies to improve the effectiveness of weapon system acquisition and support, and the efficient use of the nation's resources.■

■ *Mr. Garrity is a professor of systems acquisition management at DSMC.*

CONTROL PROCESS

LOGISTICS SUPPORT ANALYSIS

An Integral Part of the System Engineering Process

Lieutenant Colonel Samuel Craig, USAF

As weapon systems became increasingly specialized and complex it was apparent that a control process was needed to manage defense system design and development. The system engineering (SE) process, when properly applied, meets this need and is currently used by government and civilian contractors to integrate the many functional disciplines that go into defense weapons systems. The system engineering process encompasses, either directly or indirectly, the planning and integration of many functional areas, activities and products like the ones shown in Figure 1.

The system engineering process encompasses, either directly or indirectly, the planning and integration of many functional areas, activities and products.

Much can be said about the functions activities and products shown in Figure 1, but for the sake of brevity this article will focus on:

The relationship of logistics support analysis (LSA) to design and to integrated logistics support within the SE process. (Definitions are listed on page 10.)

An approach to take when applying LSA to a proposed defense system.

Discussion

An operational need can be identified for the following reason(s):

—Improved mission capability

Projected deficiency or obsolescence in an existing system

—Technological opportunity

—Opportunity to reduce operational cost (DODD 5000.1).

When a new system is the best way to meet an operational need, funds are identified through the program objective memorandum (POM) process and the Secretary of Defense approves justification for a major system new start (JMSNS). A requirement then exists to communicate this need to potential offerors; i.e., industry, academia, and government laboratories. After receiving a description of the need, the offerors normally will use the SE process (see Figure 2) to help formulate their ideas and studies in response to the need.

The SE process, which begins in the concept exploration phase, is an iterative process that converts the operational need identified by the government into technical requirements that are defined initially in the system specification, and then into development and production

Figure 1. Some System Engineering Considerations

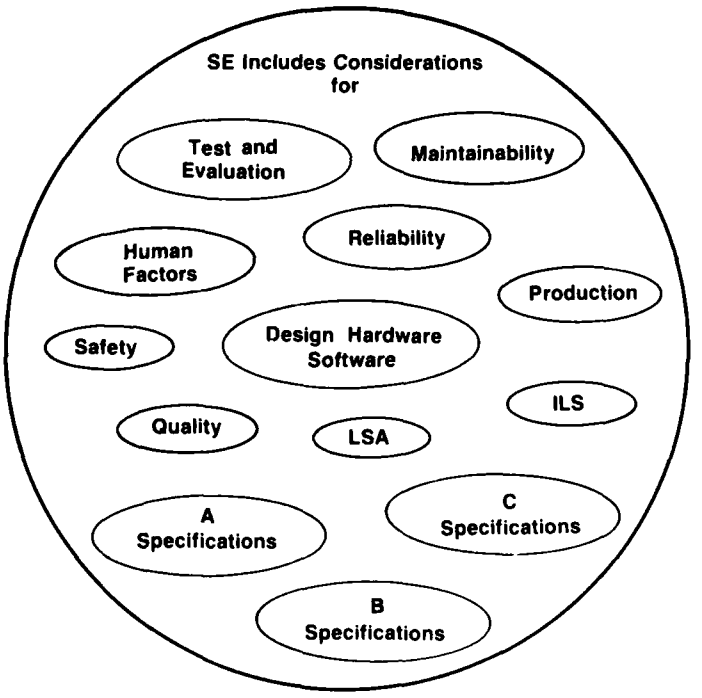
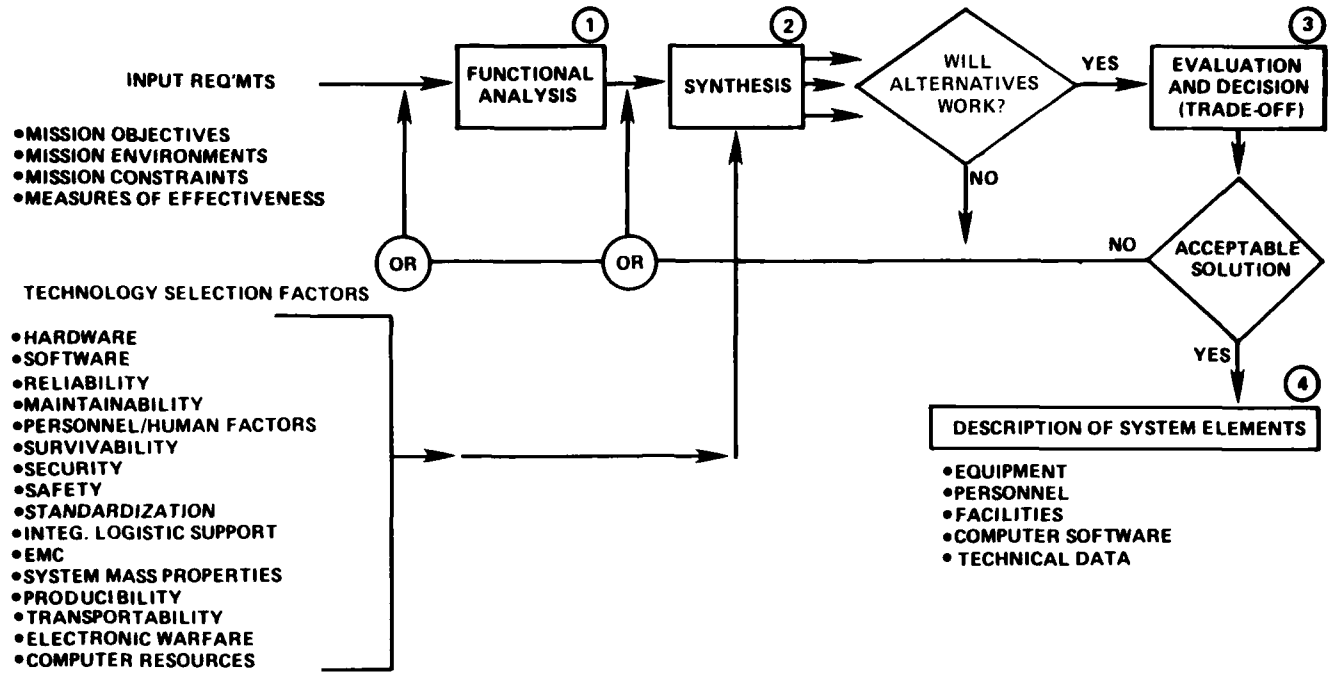


Figure 2. System Engineering Process



Courtesy Technical Management Department DSMC

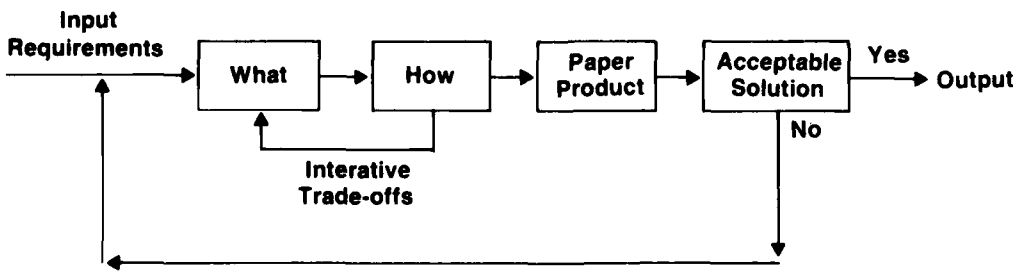
specifications later in the acquisition process.

The initial inputs to the SE process are peacetime and wartime operational mission objectives, mission environments, identifiable mission constraints, and measures of effectiveness. These inputs are used by system engineers to develop logical functional flow block diagrams to help formulate *what* technical system functions are required to satisfy the operational need. As functions are identified, "synthesis" is taking place to determine *how* functions will be performed and achieve their assigned technical performance requirements.

Operational mission objectives, environments, identifiable constraints and measures of effectiveness are initial inputs to the SE process.

A key tool, the work breakdown structure (WBS), that helps to accomplish the *how* is developed during the functional analysis and synthesis iterations of the SE process. Guidance on developing the WBS can be found in MIL-STD-881A. The WBS is used for many things; it is a systematic approach that assists in breaking func-

Figure 3. Another Way of Looking at the System Engineering Process



Courtesy Technical Management Department-DSMC

tions down into logical compartments, helps manage the allocation of technical requirements and technical budgets, and provides management visibility into work and cost performance.

System engineering trade-offs are made, within the framework of the WBS, between the *what* and *how* iterations during the SE process, using cost, schedule, performance, and readiness as factors for trade-off (see Figure 3). Based on the results of the trade-offs, alternative solutions to the operational need are identified and the best selected. The key point here is that the output of the SE process is a paper product that describes solutions in the form of equipment, personnel, facilities, computer software, and technical data.

If program managers (PMs) are truly serious about influencing design of a defense system from a logistics support perspective, then a major emphasis is needed during the iterative steps of synthesis and trade-off analysis in the SE process. Logistics support analysis is an analytical approach that can be used to make this happen, so let's take a look at the relationship of LSA to design and integrated logistics support within the SE process.

As reliability is designed into a defense system, fewer spares, repair parts, support equipment, facilities, and technical manuals will be required.

Relationship

Design and ILS are subsets of the SE process. As shown in Figure 4, the intersection of the design and ILS circles represents LSA.

The intent of LSA is to bring together design and support concepts during the SE steps of synthesis and trade-off analysis to influence the design so that the end-result will be reduced quantities, size, weight, complexity, cost, etc., of the ILS elements. For example, as reliability is designed into a defense system, fewer spares, repair parts, support equipment, facilities, and technical manuals will be required. Incorporating considerations for maintainability such as human factors, standardization and interchangeability, accessibility and simplicity during design, and design layout reduces the manpower and personnel burden regarding skills and the number of personnel required. It also provides for less complex design of support equipment, technical manuals that are easier-to-read and comprehend, and less training; likewise, it lessens the supply-support burden and provides for quick removal, replacement, and repairing of subsystems and components when failure occurs. When design is properly influenced by LSA, one result is a more cost-effective ILS resource with a significantly reduced logistics tail that requires less military airlift transports during

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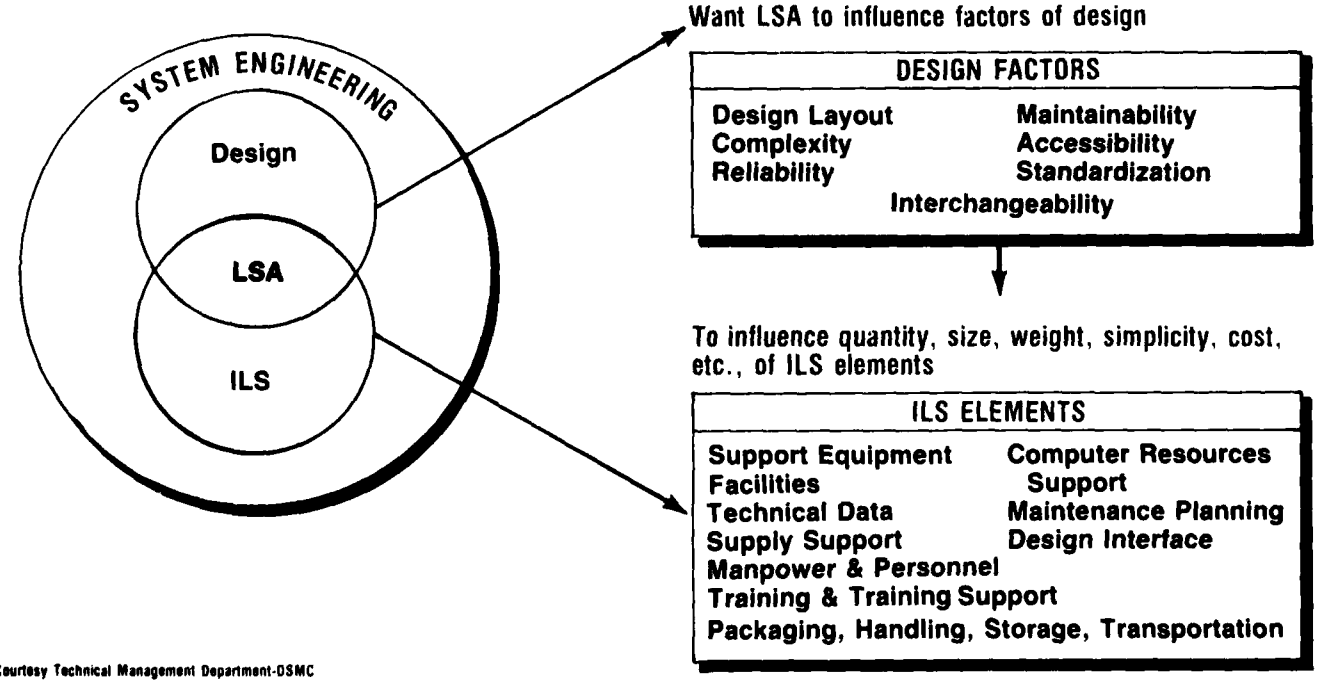
Figure 4. Subsets of the SE Process



Courtesy Technical Management Department-DSMC

Figure 5. Logistic Support Analysis Application Guidance MIL-STD 1388-1A

HQ DARCOM

TASK SECTION	PURPOSE OF TASK SECTION	TASK/SUBTASK	INFLUENCE: SYS EQUIP DESIGN	INFLUENCE: SUPPT SYS DESIGN	INFLUENCE: LOG RESRCS DATA DETERMINATION	APPLICABILITY BY PHASE: PRE CONCEPT	APPLICABILITY BY PHASE: CONCEPT	APPLICABILITY BY PHASE: D/V&I	APPLICABILITY BY PHASE: FSD	APPLICABILITY BY PHASE: PROD/DEPLOY	LSAR INTERFACE
100 — PROGRAM PLANNING & CONTROL	TO PROVIDE FOR FORMAL PROGRAM PLANNING AND REVIEW ACTIONS	101 — DEVELOPMENT OF AN EARLY LOGISTIC SUPPORT ANALYSIS STRATEGY	PRIMARY PURPOSE OF 100 SERIES TASKS IS THE MANAGEMENT AND CONTROL OF THE LSA PROGRAM			NA	G(3)	G(3)	S(3)	NA	NOT APPLICABLE
		101 2 1 — LSA STRATEGY									
		101 2 2 — UPDATES									
		102 — LOGISTIC SUPPORT ANALYSIS PLAN				NA	G	G	G	NA	NOT APPLICABLE
		102 2 1 — LSA PLAN									
		102 2 2 — UPDATES									
		103 — PROGRAM AND DESIGN REVIEWS				NA	G(2)	G(2)	G(2)	G(2)	NOT APPLICABLE
		103 2 1 — ESTABLISH REVIEW PROCEDURES									
		103 2 2 — DESIGN REVIEWS									
		103 2 3 — PROGRAM REVIEWS									
		103 2 4 — LSA REVIEW									
200 — MISSION & SUPPORT SYSTEMS DEFINITION	TO ESTABLISH SUPPORTABILITY OBJECTIVES AND SUPPORTABILITY RELATED DESIGN GOALS, THRESHOLDS AND CONSTRAINTS THROUGH COMPARISON WITH EXISTING SYSTEMS AND ANALYSES OF SUPPORTABILITY, COST AND READINESS DRIVERS	201 — USE STUDY				G	G	G	G	NA	
		201 2 1 — SUPPORTABILITY FACTORS	X	X							INDIRECTLY (4)
		201 2 2 — QUANTITATIVE FACTORS	X	X							
		201 2 3 — FIELD VISITS	X	X							
		201 2 4 — USE STUDY REPORT AND UPDATES	X	X							
		202 — MISSION HARDWARE, SOFTWARE AND SUPPORT SYSTEM STANDARDIZATION				NA	G(2)	G(2)	G(2)	C(2)	
		202 2 1 — SUPPORTABILITY CONSTRAINTS	X	X	X						INDIRECTLY (4)
		202 2 2 — SUPPORTABILITY CHARACTERISTICS	X								
		202 2 3 — RECOMMENDED APPROACHES	X	X							
		202 2 4 — RISKS	X	X	X						
		203 — COMPARATIVE ANALYSIS				G	G	G	G	NA	
		203 2 1 — IDENTIFY COMPARATIVE SYSTEMS	X	X		G	G	G	NA		
		203 2 2 — BASELINE COMPARISION SYSTEM	X	X		G	G	G	G	NA	
		203 2 3 — COMPARATIVE SYSTEM CHARACTERISTICS	X	X		G	G	G	NA	NA	
		203 2 4 — QUALITATIVE SUPPORTABILITY PROBLEMS	X	X			G	G	G	NA	INDIRECTLY (4)
		203 2 5 — SUPPORTABILITY COST AND READINESS DRIVER	X	X		G	G	G	G	NA	
		203 2 6 — UNIQUE SYSTEM DRIVERS	X	X		G	G	G	NA	NA	
		203 2 7 — UPDATES	X	X		NA	G	G	G	NA	
		203 2 8 — RISKS AND ASSUMPTIONS	X	X		G	G	G	G	NA	
		204 — TECHNOLOGICAL OPPORTUNITIES				NA	G	G	S	NA	
		204 2 1 — RECOMMENDED DESIGN OBJECTIVES	X	X							INDIRECTLY (4)
		204 2 2 — UPDATES	X	X							
		204 2 3 — RISKS	X	X							
		205 — SUPPORTABILITY AND SUPPORTABILITY RELATED DESIGN FACTORS		X		NA	G	G	G	NA	
		205 2 1 — SUPPORTABILITY CHARACTERISTICS				NA	G	G	NA	NA	
		205 2 2 — SUPPORTABILITY OBJECTIVES & ASSOCIATED RISKS	X	X		NA	G	G	NA	NA	A RECORD
		205 2 3 — SPECIFICATION REQUIREMENTS	X	X		NA	G	G	G	G	
		205 2 4 — NATO CONSTRAINTS	X	X		NA	G	G	NA	NA	
		205 2 5 — SUPPORTABILITY GOALS AND THRESHOLDS	X	X		NA	NA	G	NA	NA	
300 — PREPARATION AND EVALUATION OF ALTERNATIVES	TO OPTIMIZE THE SUPPORT SYSTEM FOR THE NEW ITEM AND TO DEVELOP A SYSTEM WHICH ACHIEVES THE BEST BALANCE BETWEEN COST, SCHEDULE, PERFORMANCE, AND SUPPORTABILITY	301 — FUNCTIONAL REQUIREMENTS IDENTIFICATION				NA	G	G	G	C	
		301 2 1 — FUNCTIONAL REQUIREMENTS		X		NA	G	G	S(1)	C(1)	C RECORD
		301 2 2 — UNIQUE FUNCTIONAL REQUIREMENTS		X		NA	G	G	S(1)	C(1)	C RECORD
		301 2 3 — RISKS		X		NA	G	G	S(1)	C(1)	
		301 2 4 — OPERATIONS AND MAINTENANCE TASKS		X	X	NA	S	G	G	C	B/C/D RECORDS
		301 2 5 — DESIGN ALTERNATIVES	X			NA	G	G	G	C	
		301 2 6 — UPDATES		X	X	NA	G	G	G	C	
		302 — SUPPORT SYSTEM ALTERNATIVES				NA	G	G	G	C(1)	
		302 2 1 — ALTERNATIVE SUPPORT CONCEPTS		X		NA	G	G	NA	NA	
		302 2 2 — SUPPORT CONCEPT UPDATES		X		NA	G	G	S	NA	
		302 2 3 — ALTERNATIVE SUPPORT PLANS		X		NA	S	S	G	C(1)	INDIRECTLY (4)
		302 2 4 — SUPPORT PLAN UPDATES		X		NA	S	S	G	C(1)	
		302 4 5 — RISKS		X		NA	G	G	G	C(1)	
		303 — EVALUATION OF ALTERNATIVES AND TRADEOFF ANALYSIS				NA	G	G	G	C	
		303 2 1 — TRADEOFF CRITERIA	X	X	X	NA	G	G	G	C	
		303 2 2 — SUPPORT SYSTEM TRADEOFFS		X		NA	G	G	G	C	E/F/G RECORDS
		303 2 3 — SYSTEM TRADEOFFS	X	X		NA	G	G	G	C	
		303 2 4 — READINESS SENSITIVITIES	X	X		NA	G	G	G	NA	
		303 2 5 — MANPOWER AND PERSONNEL TRADEOFFS	X	X	X	NA	G	G	G	NA	
		303 2 6 — TRAINING TRADEOFFS	X	X	X	NA	G	G	G	C	
		303 2 7 — REPAIR LEVEL ANALYSES		X	X	NA	S(1)	G	G	C	C RECORD
		303 2 8 — DIAGNOSTIC TRADEOFFS	X	X		NA	G	G	S(1)	NA	
		303 2 9 — COMPARATIVE EVALUATIONS		X		NA	G	G	S(1)	C	
		303 2 10 — ENERGY TRADEOFFS	X	X	X	NA	G	G	S	C	
		303 2 11 — SURVIVABILITY TRADEOFFS	X	X		NA	G	G	G	C	
		303 2 12 — TRANSPORTABILITY TRADEOFFS	X	X		NA	G	G	NA	NA	
400 — DETERMINATION OF LOGISTIC SUPPORT RESOURCE REQUIREMENTS	TO IDENTIFY THE LOGISTIC SUPPORT RESOURCE REQUIREMENTS OF THE NEW SYSTEM IN ITS OPERATIONAL ENVIRONMENT(S) AND TO DEVELOP PLANS FOR POST PRODUCTION SUPPORT	401 — TASK ANALYSIS				NA	NA	S	G	C	
		401 2 1 — TASK ANALYSIS			X	NA	NA	S	G	C	
		401 2 2 — ANALYSIS DOCUMENTATION			X	NA	NA	S	G	C	C/D/D1 RECORD
		401 2 3 — NEW/CRITICAL SUPPORT RESOURCES			X	NA	NA	S	G	C	E/F/G RECORDS
		401 2 4 — TRAINING REQUIREMENTS AND RECOMMENDATIONS			X	NA	NA	S	G	C	D1 RECORD
		401 2 5 — DESIGN IMPROVEMENTS	X	X		NA	NA	S	G	C	
		401 2 6 — MANAGEMENT PLANS			X	NA	NA	S	G	C	
		401 2 7 — TRANSPORTABILITY ANALYSIS	X	X		NA	NA	G	S(1)	C(1)	J RECORD
		401 2 8 — PROVISIONING REQUIREMENTS			X	NA	NA	S	G	C	H/H1 RECORDS
		401 2 9 — VALIDATION	X	X	X	NA	NA	S	G	C	ALL RECORDS (5)
		401 2 10 — ILS OUTPUT PRODUCTS			X	NA	NA	S	G	C	
		401 2 11 — LSAR UPDATES	X	X	X	NA	NA	S	G	C	ALL RECORDS (5)
		402 — EARLY FIELDING ANALYSIS				NA	NA	NA	G	C	
		402 2 1 — NEW SYSTEM IMPACT			X						
		402 2 2 — SOURCES OF MANPOWER AND PERSONNEL SKILLS			X						
		402 2 3 — IMPACT OF RESOURCE SHORTFALLS			X						
		402 2 4 — COMBAT RESOURCE REQUIREMENTS			X						
		402 2 5 — PLANS FOR PROBLEM RESOLUTION			X						
		403 — POST PRODUCTION SUPPORT ANALYSIS				NA	NA	NA	NA	G	
		403 2 — POST PRODUCTION SUPPORT PLAN		X	X						
500 — SUPPORTABILITY ASSESSMENT	TO ASSURE THAT SPECIFIED REQUIREMENTS ARE ACHIEVED AND DEFICIENCIES CORRECTED	501 — SUPPORTABILITY TEST, EVALUATION, AND VERIFICATION				NA	G	G	G	G	
		501 2 1 — TEST AND EVALUATION STRATEGY	X	X	X	NA	G	G	S	NA	
		501 2 2 — OBJECTIVES AND CRITERIA	X	X	X	NA	NA	G	G		
		501 2 3 — UPDATES AND CORRECTIVE ACTIONS	X	X	X	NA	NA	G	G	S	
		501 2 4 — SUPPORTABILITY ASSESSMENT PLAN (POST DEPLOYMENT)	X	X	X	NA	NA	NA	G	S	ALL RECORDS (5)
		501 2 5 — SUPPORTABILITY ASSESSMENT (POST DEPLOYMENT)	X	X	X	NA	NA	NA	NA	G	

DRCSM [illegible]

APPLICABILITY BY PHASE CODE DEFINITIONS

- S — SELECTIVELY APPLICABLE
- G — GENERALLY APPLICABLE
- C — GENERALLY APPLICABLE TO DESIGN CHANGES ONLY
- NA — NOT APPLICABLE
- (1) — REQUIRES CONSIDERABLE INTERPRETATION OF INTENT TO BE COST EFFECTIVE
  MIL STD 1388 1A IS NOT THE PRIMARY IMPLEMENTATION DOCUMENT. OTHER MIL STD'S OR STATEMENT OF WORK REQUIREMENTS MUST BE INCLUDED TO DEFINE THE TOTAL REQUIREMENTS
- (3) — COMPLETED JUST PRIOR TO INITIATION OF THE PHASE

LOGISTIC SUPPORT ANALYSIS T/ SK RELATIONSHIPS		APPLICABLE DATA ITEM DESCRIPTIONS (DIDS)	
TASKS WHICH ARE AN INPUT [a]	TASKS WHICH RECEIVE DATA [b]	DID	REMARKS
	[illegible] SUPPORT ANALYSIS PLAN	DI-L-7114 LOGISTIC SUPPORT ANALYSIS STRATEGY REPORT	
101 DEVELOPMENT OF AN EARLY LSA STRATEGY		DI-S-7017A LOGISTIC SUPPORT ANALYSIS PLAN DI-L-6138 INTEGRATED SUPPORT PLAN (ISP)	DI-L-6138 WILL BE USED TO OBTAIN THE LSA PLAN WHEN AN ISP IS REQUIRED
		DI-S-7017A LOGISTIC SUPPORT ANALYSIS PLAN DI-A-7088 CONFERENCE AGENDA DI-A-7089 CONFERENCE MINUTES	DI-S-7017A APPLIES TO SUBTASK 103 2 1 ONLY DI-A-7088 AND 7089 ARE GENERIC DIDS WHICH APPLY TO ANY CONFERENCE OR REVIEW
	102 MISSION HARDWARE, SOFTWARE AND SUPPORT SYSTEM STANDARDIZATION 202 COMPARATIVE ANALYSIS 301 FUNCTIONAL REQUIREMENTS	DI-S-7115 USE STUDY REPORT	
201 [illegible]	205 SUPPORTABILITY AND SUPPORTABILITY RELATED DESIGN FACTORS	DI-S-3606 SYSTEM/DESIGN TRADE STUDY REPORTS DI-E-7026 PARTS CONTROL PROGRAM PLAN DI-E-7027 PROGRAM PARTS SELECTION LIST (PPSL) DI-E-7028 NONSTANDARD PARTS APPROVAL REQUESTS/PROPOSED ADDITIONS TO AN APPROVED PPSL DI-E-7029 MILITARY DETAIL SPECIFICATIONS AND SPECIFICATION SHEETS DI-E-7030 TEST DATA FOR NONSTANDARD PARTS	DI-E-7026 THROUGH DI-E-7030 PERTAIN TO THE PARTS CONTROL PROGRAM. THESE DIDS REQUIRE THE CITING OF MIL-STD-965 ON CONTRACT
202 [illegible]	208 TECHNOLOGICAL OPPORTUNITIES 205 SUPPORTABILITY AND SUPPORTABILITY RELATED DESIGN FACTORS 301 FUNCTIONAL REQUIREMENTS 501 SUPPORTABILITY TEST, EVALUATION AND VERIFICATION	DI-S-7116 COMPARATIVE ANALYSIS REPORT	
202 COMPARATIVE ANALYSIS	205 SUPPORTABILITY AND SUPPORTABILITY RELATED DESIGN FACTORS	DI-S-7117 TECHNOLOGICAL OPPORTUNITIES REPORT	
201 MISSION HARDWARE, SOFTWARE AND SUPPORT SYSTEM STANDARDIZATION 202 COMPARATIVE ANALYSIS 204 TECHNOLOGICAL OPPORTUNITIES 301 EVALUATION OF ALTERNATIVES AND TRADEOFF ANALYSIS	301 FUNCTIONAL REQUIREMENTS 302 SUPPORT SYSTEM ALTERNATIVES 303 EVALUATION OF ALTERNATIVES AND TRADEOFF ANALYSIS 401 TASK ANALYSES 501 SUPPORTABILITY TEST, EVALUATION AND VERIFICATION	DI-S-3606 SYSTEM/DESIGN TRADE STUDY REPORTS DI-S-6171A LOGISTIC SUPPORT ANALYSIS RECORD (LSAR)	DI-S-6171A *APPLIABLE TO SUBTASK 205 2 3 ONLY (DATA* RECORD A). SEE DARCOM-P-750-16 FOR SPECIFIC LSAR GUIDANCE AND FORMATS
201 USE STUDY 202 COMPARATIVE ANALYSIS 205 SUPPORTABILITY AND SUPPORTABILITY RELATED DESIGN FACTORS	302 SUPPORT SYSTEM ALTERNATIVES 401 TASK ANALYSIS	DI-S-3606 SYSTEM/DESIGN TRADE STUDY REPORTS DI-S-6171A LOGISTIC SUPPORT ANALYSIS RECORD (LSAR)	DI-S-6171A APPLIES TO SUBTASKS 301 2 4 AND 301 2 6 *ONLY * DATA REQUIREMENTS MUST BE COORDINATED* WITH RELIABILITY, MAINTAINABILITY, AND HUMAN ENGINEERING PROGRAM REQUIREMENTS * SEE DARCOM-P-750-16 FOR SPECIFIC LSAR GUIDANCE AND FORMATS
205 SUPPORTABILITY AND SUPPORTABILITY RELATED DESIGN FACTORS 301 FUNCTIONAL REQUIREMENTS	303 EVALUATION OF ALTERNATIVES AND TRADEOFF ANALYSIS	DI-S-3606 SYSTEM/DESIGN TRADE STUDY REPORTS	
205 SUPPORTABILITY AND SUPPORTABILITY RELATED DESIGN FACTORS 302 SUPPORT SYSTEM ALTERNATIVES	205 SUPPORTABILITY AND SUPPORTABILITY RELATED DESIGN FACTORS 401 TASK ANALYSIS 402 EARLY FIELDING ANALYSIS 501 SUPPORTABILITY TEST, EVALUATION AND VERIFICATION	DI-S-3606 SYSTEM/DESIGN TRADE STUDY REPORTS	
205 SUPPORTABILITY AND SUPPORTABILITY RELATED DESIGN FACTORS 301 FUNCTIONAL REQUIREMENTS 301 EVALUATION OF ALTERNATIVES AND TRADEOFF ANALYSIS	402 EARLY FIELDING ANALYSIS	DI-S-3606 SYSTEM/DESIGN TRADE STUDY REPORTS DI-S-6171A LOGISTIC SUPPORT ANALYSIS RECORD (LSAR)	DI-S-3606 APPLIES TO SUBTASKS 401 2 5, 401 2 6, AND 401 2 9 *DI-S-6171A REQUIRES APPLIC TO SUBTASKS 401 2 2, 401 2 3* 401 2 4, 401 2 7, 401 2 8, 401 2 9 AND 401 2 11. SEE DARCOM-P-750-16 FOR SPECIFIC LSAR GUIDANCE AND FORMATS. REQUIRES FULL COORDINATION OF ILS ELEMENT DATA REQUIREMENTS
301 EVALUATION OF ALTERNATIVES AND TRADEOFF ANALYSIS 401 TASK ANALYSIS	401 POST PRODUCTION SUPPORT ANALYSIS	DI-S-7118 EARLY FIELDING ANALYSIS REPORT	
402 EARLY FIELDING ANALYSIS		DI-P-7119 POST PRODUCTION SUPPORT PLAN	
201 COMPARATIVE ANALYSIS 205 SUPPORTABILITY AND SUPPORTABILITY RELATED DESIGN FACTORS 301 EVALUATION OF ALTERNATIVE AND TRADEOFF ANALYSIS		DI-S-7120 SUPPORTABILITY ASSESSMENT PLAN DI-S-7121 SUPPORTABILITY ASSESSMENT REPORT	DI-S-7120 APPLIES TO SUBTASKS 501 2 1, 501 2 2, AND 502 2 4. DI-S-7121 APPLIES TO SUBTASKS 501 2 3 AND 501 2 5. NOTES: THESE DATA REQUIREMENTS MUST BE COORDINATED WITH OTHER SYSTEM TEST PLANNING AND REPORTING REQUIREMENTS

[a] THESE TASKS PROVIDE DATA TO OTHER TASKS WHICH INTERFACE WITH LSAR DATA RECORDS.
[b] POTENTIALLY TESTING COULD CAUSE REVISION OF ALL LSAR DATA RECORDS. HOWEVER, THIS REVISION WILL BE A RESULT OF ANALYSIS PERFORMED UNDER OTHER LSA TASKS. THE EXCEPTION IS THE BA01 RECORDS WHICH RECORD MEASURED DATA.
[c] THESE TASKS ARE INPUTS TO THE TASK STATED IN COLUMN 1.
[d] THESE TASKS RECEIVE INPUT FROM THE TASK LISTED IN COLUMN 1.

peacetime and wartime operational deployment scenarios.

Now that we have discussed the relationship, let's look at an approach to LSA.

Approach

To use LSA effectively, supportability *constraints* associated with the mission, operational scenario, operational environment, maintenance concept, affordability, and the user must be identified in the pre-concept and concept exploration phase. This type of information should be identified in the justification for major system new start (JMSNS) document.

Some typical constraints are:

—Standardization with already existing systems

—Standardization and interchangeability

—Turnaround times

—Readiness requirements

—Sustainability requirements

—Maintenance concept

—Numbers of people

—Skill levels

—Basing concept

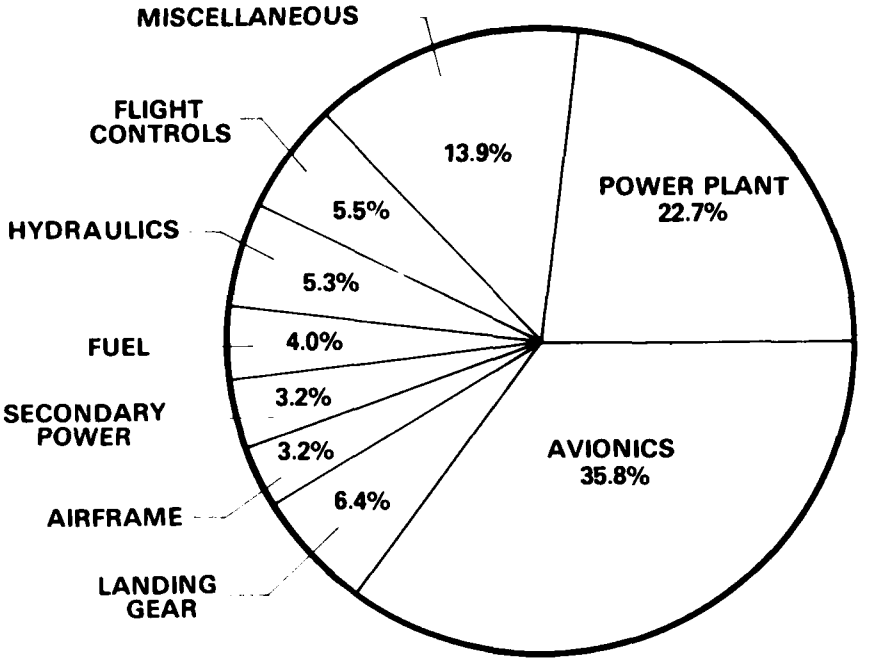
—Airlift capabilities.

If this type of information is not identified in the JMSNS, the PM should be asking these questions: *why not*, and *who* represents the *Office of Primary Responsibility* for the information? The PM should, as soon as possible, establish an action item and date for delivery of the information.

To get started two LSA tasks (see Figure 5), the use study—task 201—and comparative analysis—task 203—will have to accomplished 99.9 percent of the time if you wish to be successful. Both tasks should be accomplished as applicable in the pre-concept and concept exploration phase. Note that the sub-tasks should be chosen selectively and tailored to your program. The use study and comparative analysis tasks play important roles in helping to identify the supportability constraints which help you to develop the LSA strategy for your program.

The use study relates to intended use of the proposed system, operational environment, maintenance concept, projected mission, mission frequency, mission duration, basing concept, anticipated service life, etc. Use-study data are provided to the contractor by the government.

Figure 6. Sources of Aircraft Maintenance Actions



Courtesy of OSD AL

The comparative analysis helps to formulate a baseline for the proposed system by looking at prior and current systems that may be similar in certain aspects. The intent is to identify designs and subsystems that are good for possible incorporation in the proposed system; also, to identify designs and subsystems that are poor performers as candidates for new design, modification, new technology or a combination thereof. This type of data is good for establishing a baseline from which to project support for the proposed system.

An example showing one data point of a comparative analysis is shown in Figure 6. Let's suppose that the maintenance-action percentages represent those of a prior generation system similar to the one being proposed. Although this would be just one data point among different comparative analyses, it points out poor performers—like the power plant and avionics that will require additional data to help determine the best approach to improve poor performers. Some options are redesign, new design layout, modularity, state-of-the-art technology, modification, etc.

Additional sources of information within the different services on current and prior systems are Air Force 66-1 and 66-5 data, Navy 3-M data, and The Army Maintenance Management System (TAMMS) data. Also, lessons-learned information is available from the military services' lessons-learned organizations. Points of Contact are:

Army

Commander
US Army MAT COM Material Readiness Support Activity (MRSA)
Attn: AMXMD-EI
Lexington, KY 40511-5101
Autovon: 745-3393/4154
Commercial: (606) 293-4154/3393

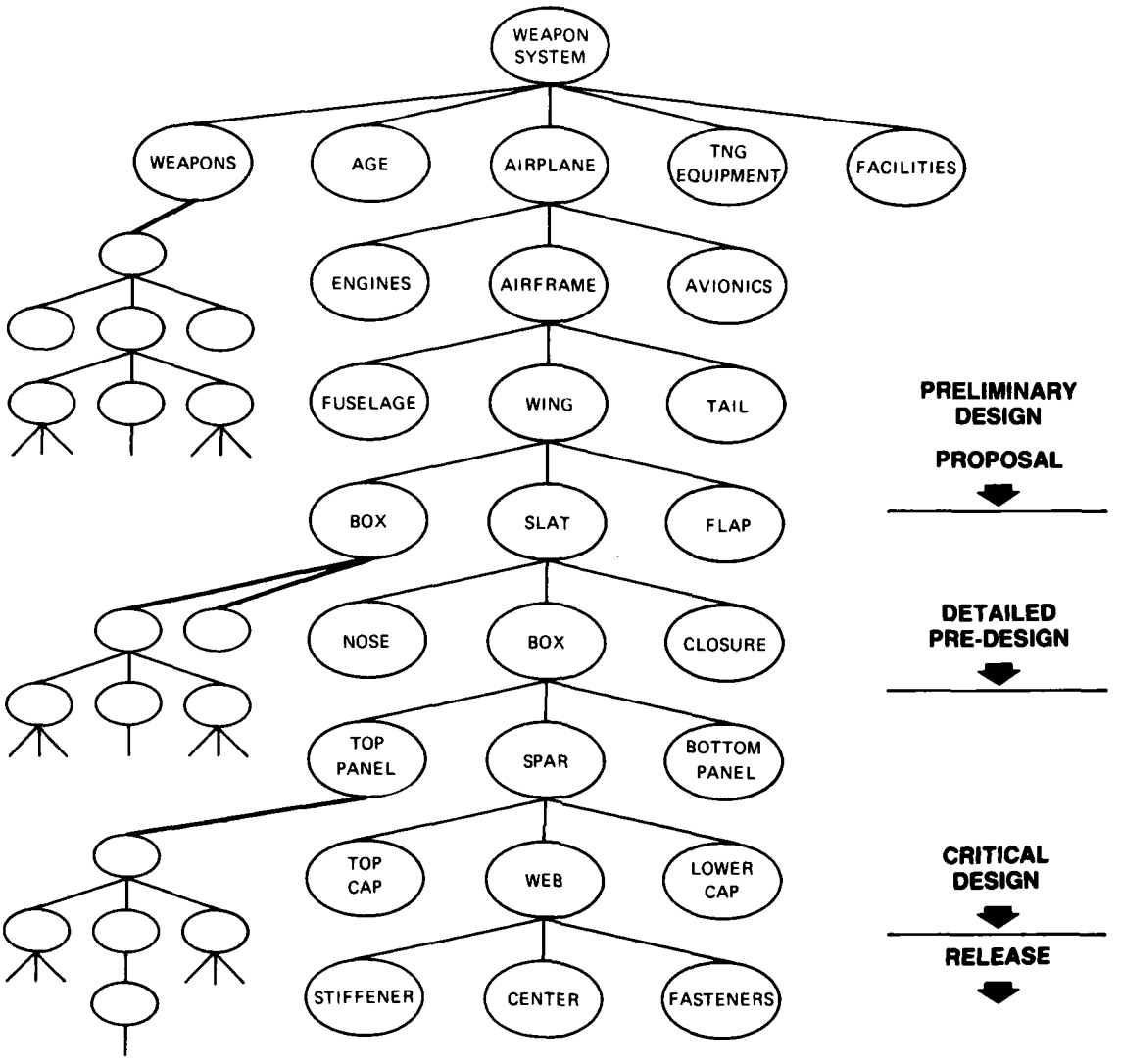
Air Force

Directorate of Systems Support
AFALC/LSL
Wright-Patterson AFB, OH 45433
Autovon: 785-3161
Commercial: (513) 255-3161

Navy

Naval Air Test Center
Code RW 82 A
Patuxent River, MD 20670-5304
Autovon: 356-1232/1240
Commercial: (301) 863-1232/1240

Figure 7. System Design Process



Courtesy Technical Management Department-DSMC

Navy Logistics Review Audits

Chief of Naval Operations
Attn: OPNAV 403
Washington, D.C. 20350-2000
Autovon: 222-5921/7886
Commercial: (202) 692-5921/7886

EXAMPLES

Let us assume that the solution chosen and approved by the government, from the alternative solutions submitted by the offerors to satisfy the aforementioned operation need, is a fighter aircraft.

I mentioned that the WBS is developed during the interative steps of functional analysis and synthesis in the system engineering process. A typical WBS for design process is shown in Figure 7.

"You get what you pay for," or "you pay for what you get."

A couple of suggestions are worth mentioning here:

—To influence weapon system support during design requires that *manhours* of effort for reliability, maintainability, equipment, software, and human factor engineers as well as acquisition logisticians must be identified so that they will be represented with design engineers within the applicable compartments of the WBS. Their presence is important because this is where the action is; this is where the synthesis *(how)* and the trade-off analyses among cost, schedule, performance, and supportability will take place.

—*Money* is required for this level of effort to influence support during design. We must recognize that "You get what you pay for" or "You pay for what you get." This is why the program manager should be asking the question: "What is my return on investment for those tasks that are being suggested to be included in the statement of work (SOW)?"

GLOSSARY

Definitions That Will Help You Understand

SYSTEM ENGINEERING. "The application of scientific and engineering efforts to (1) transform an operational need into a description of a system configuration which best satisfies the operational need according to the measures of effectiveness; (2) integrate related technical parameters and assure compatibility of all physical, functional and technical program interfaces in a manner which optimizes the total system definition and design; (3) integrate the efforts of all engineering disciplines and specialties into the total engineering effort." *Army Field Manual* 770-78.

SYSTEM ENGINEERING PROCESS. The iterative, logical sequence of analysis, design, test and decision activities that transforms an operational need into the descriptions required for production and fielding of all operational and support system elements.

DESIGN. Plans, sketches, drawings, and specifications that serve as a pattern from which to develop and produce systems, subsystems, components, their interfaces, materials, and the processes to be used.

INTEGRATED LOGISTICS SUPPORT. A disciplined, unified, and iterative approach to the management and technical activities necessary to:

—Integrate support considerations into system and equipment design
—Develop support requirements that are related consistently to readiness objectives, to design, and to each other
—Acquire the required support
—Provide the required support during the operational phase at minimum cost (DODD 5000.39).

LOGISTICS SUPPORT ANALYSIS (LSA). The selective application of scientific and engineering efforts undertaken during the acquisition process, as part of the systems engineering process, to assist in:

—Causing support considerations to influence design
—Defining support requirements that are related optimally to design and to each other
—Acquiring the required support
—Providing the required support during the operational phase at minimum cost (DODD 5000.39).

SYSTEM SPECIFICATION. This type of specification states the technical and mission requirements for a system as an entity, allocates requirements to functional areas, and defines the interfaces between or among the functional areas. Normally, the initial version of a system specification is based on parameters developed during the concept formulation period or an exploratory preliminary design period of feasibility studies and analyses. (MIL-STD-490).

DEVELOPMENT SPECIFICATIONS. Development specifications state the requirements for the design or engineering development of a product during the development period. Each development specification shall be in sufficient detail to describe effectively the performance characteristics that each configuration item is to achieve when a developed item is to evolve into a detail design for production. (MIL-STD-490).

PRODUCT SPECIFICATIONS. Product specifications are applicable to any item below the system level, and may be oriented toward procurement of a product through specification of primarily function (performance) requirements or primarily fabrication (detailed design) requirements.

—A product function specification states (1) the complete performance requirements of the product for the intended use, and (2) necessary interface and interchangeability characteristics. It covers form, fit, and function.

—A product fabrication specification states (1) a detailed description of the parts and assemblies of the product, usually by prescribing compliance with a set of drawings, and (2) those performance requirements and corresponding tests and inspections necessary to assure proper fabrication, adjustment, and assembly techniques. (MIL-STD-490).■

Remember that selection of LSA tasks should be based upon the constraints and special considerations in your program. The tasks identified in the SOW should be considered by the contractor in each applicable compartment of the WBS.

Let's consider the standardization and interchangeability constraint I mentioned above. This LSA task would be identified in the SOW as task 202, along with the applicable subtasks. Notice code (2) at the bottom of Figure 5, which states that other information is required in the contract package to support standardization.

One example that depicts the influence a task like standardization and interchangeability can have on design is shown in Figure 8. The example shows that the F-16 aircraft, developed by General Dynamics Corporation, Fort Worth, Texas, has five integrated servo actuators that are common and interchangeable and operate the flaperons, horizontal tails, and the rudder; the flaperons are interchangeable left and right, horizontal tails are interchangeable left and right, and rotary actuators that operate the leading edge flaps are interchangeable left and right. Notice that this example is addressing standardization and interchangeability in the airframe, fuselage, wing and tail of the WBS of Figure 7. The key point is that if you desire to get maximum return on this task it has to be identified early in the design process while the designer is putting the design on paper or cathode ray tube.

The F-16 aircraft has five integrated servo actuators that are common and interchangeable.

What are the benefits derived from a task like standardization and inter-

Figure 9. F-16 Aircraft

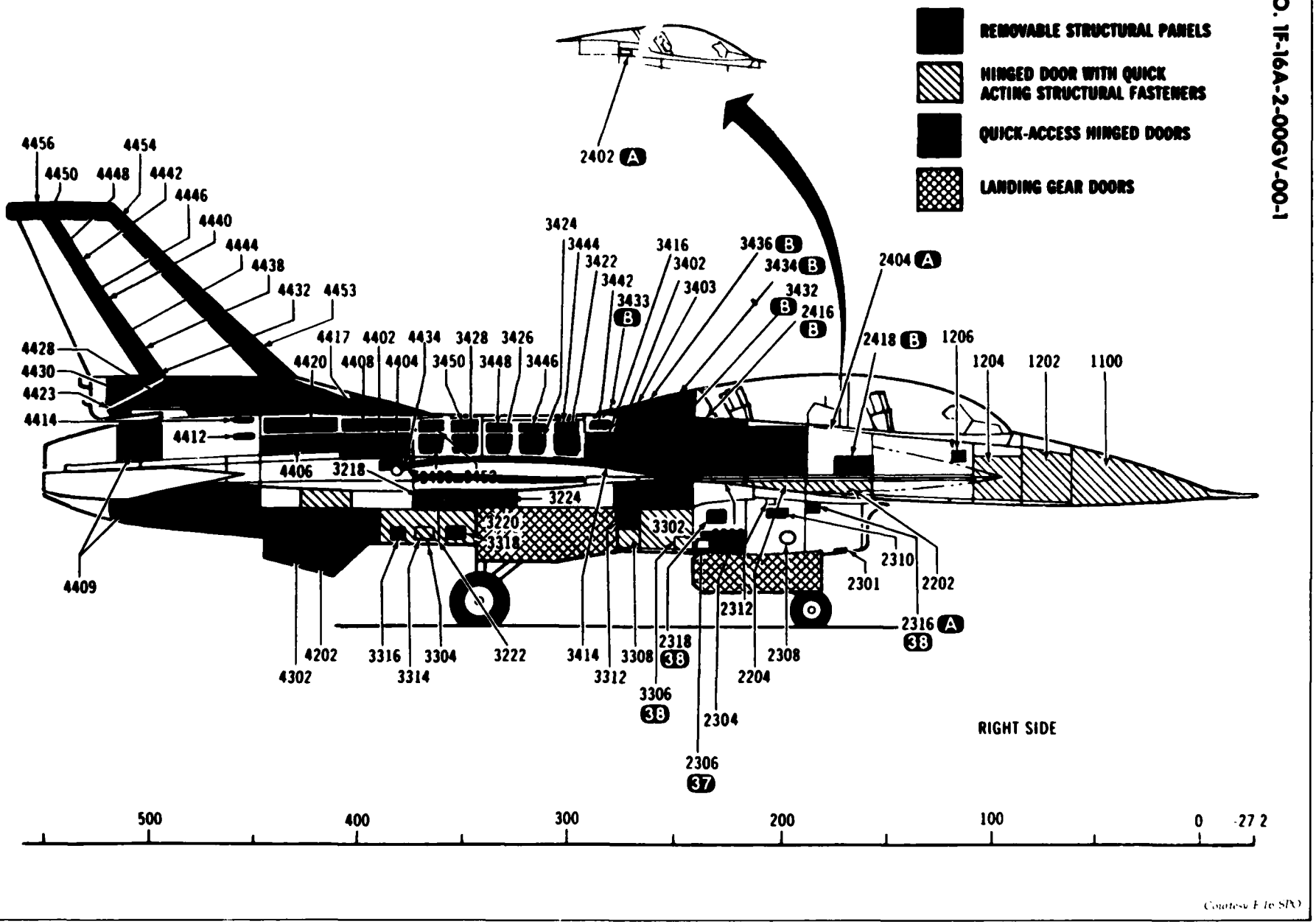
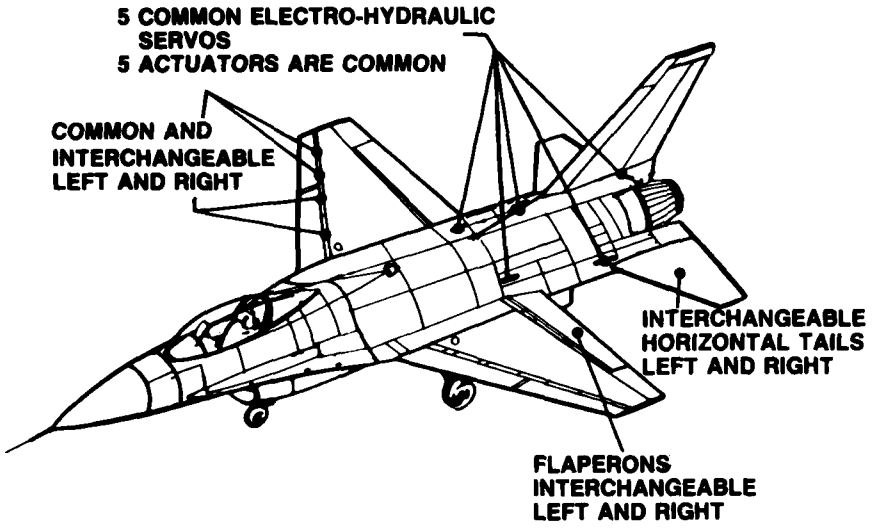


Figure 8. F-16 Aircraft



Courtesy F-16 SPO

changeability? There are several: It reduces the number of spares and repair parts required, therefore saving money; reduces the quantity of new part numbers entering the inventory, which lessens administrative tracking and documentation cost; helps technical-manual writers simplify texts and illustrations; and, most of all, provides simplicity and flexibility to maintenance personnel in support of the weapon system, which enhances system readiness.

Let's look at another constraint mentioned above, turnaround times. Some examples of turnaround times might be:

—Quick turnaround without weapons loading, 3 people, 10 minutes

—Inspect, service liquid oxygen, refuel

—Quick turnaround with simultaneous servicing and weapons loading, 11 people, 10 minutes

—Inspect, service liquid oxygen, refuel, and load weapons.

The LSA tasks 205 and 301 would be identified in the SOW with applicable subtasks. Note that these tasks would allow the contractor to address many supportability-related design factors and functional requirements, but here we will look only at quick turnaround.

Again, let's use the F-16 as an example (see Figure 9) and then look at the airframe compartment of the WBS (see Figure 7). While considering quick turnaround during the design process, accessibility becomes a key design factor. Sixty percent of the surface of the F-16 aircraft is removable; the surface contains 250 removable access doors and covers. Approximately 95 percent of the airplane's components are single-tiered, which means that maintenance personnel have immediate access to the component once the access door or cover is opened.

Sixty percent of the surface of the F-16 aircraft is removable—the surface contains 250 removable access doors and covers.

A concerted effort should be made by all of the functional people working within different compartments of the WBS to integrate LSA tasks. The two examples I mentioned above can be used to explain this point. By considering standardization and interchangeability with the turnaround requirements, the 250 access doors and covers were designed to be interchangeable from aircraft to aircraft, and four standard tools were designed for external access. Another point to be made is the interface among different WBS compartments. While considering turnaround and standardization and interchangeability tasks at the airframe level of the WBS, consideration should be given to what type of fasteners, compartment located at the bottom of the WBS (Figure 7), will be used to support the design of the airframe.

Lessons-learned reports tell us that fastener problems like material, length, torque, susceptibility to damage, tools, etc., cause considerable problems for maintenance personnel in the field. The F-16 aircraft designers were able to reduce the number of fasteners down to 47 kinds of standard fasteners—from 226 for the F-111, and 75 for the YF-16.

Conclusion

There are basic things that happen to increase the probability that the weapon system will be supported, across all of the ILS elements, when delivered to the field.

Program Managers Should:

—Identify supportability constraints in the program no later than concept exploration

—Be an advocate for dollars to support LSA

—Ask questions about recommended LSA tasks to be included in the SOW

—Select only LSA tasks that can be justified and project at least a 4-1 savings to investment ratio over a 5-year period of operation (based on my experience in the productivity, reliability, availability, maintainability (PRAM) program office)

—Put ILS requirements into the specifications

—Ensure that ILS and LSA are integral parts of the contractor's systems engineering process (two key places to look are in the contractor's system engineering plan and the integrated support plan)

—Use LSA as an analytical tool early in the design process to influence engineering functions like reliability, maintainability, design layout, accessibility, standardization and interchangeability, complexity, etc., to influence, among other things, quantity, size, weight, and cost of the ILS elements. ■

Strategic Planning in U.S. Army

Armaments and Munitions

Lieutenant Colonel O. B. Koropey, USA
Edward Fennell

"If you don't know where you're going, chances are you'll never get there." These words summarize the need for strategic planning in any organization. Recognizing there are many different interpretations of the term, "strategic planning," we will define this to be a process whose purpose is to bring about and maintain a positive match between an organization and its environment, addressing the broadest aspects of the organization, and considering the near-, mid-, and long-range time frames.[1]

Strategic planning was revitalized of necessity at the Armament Research and Development Center (ARDC) immediately after the organization was established in July 1983. Several major organizational shakeups dating back to the 1970s had broken apart, then recombined the Army's armament and munitions community setting the stage for a comprehensive planning effort.

The core of the organization is located at Picatinny Arsenal, Dover, N.J., with a major element at Watervliet, N.Y. Picatinny evolved from modest origins as a powder depot in the 1880s, to a munitions manufacturing facility during World War II, to its current role as the Army's research and development establishment for systems of guns and bullets. The ARDC's antecedents had made some noteworthy contributions to national defense. Some examples of their work, often accomplished in conjunction with private industry, are the development of the 155mm M198 Howitzer, the Squad Automatic Weapon, the Copperhead laser guided artillery projectile, the entire family of scatterable mines (FASCAM), and the M1 tank's new 120mm armament.

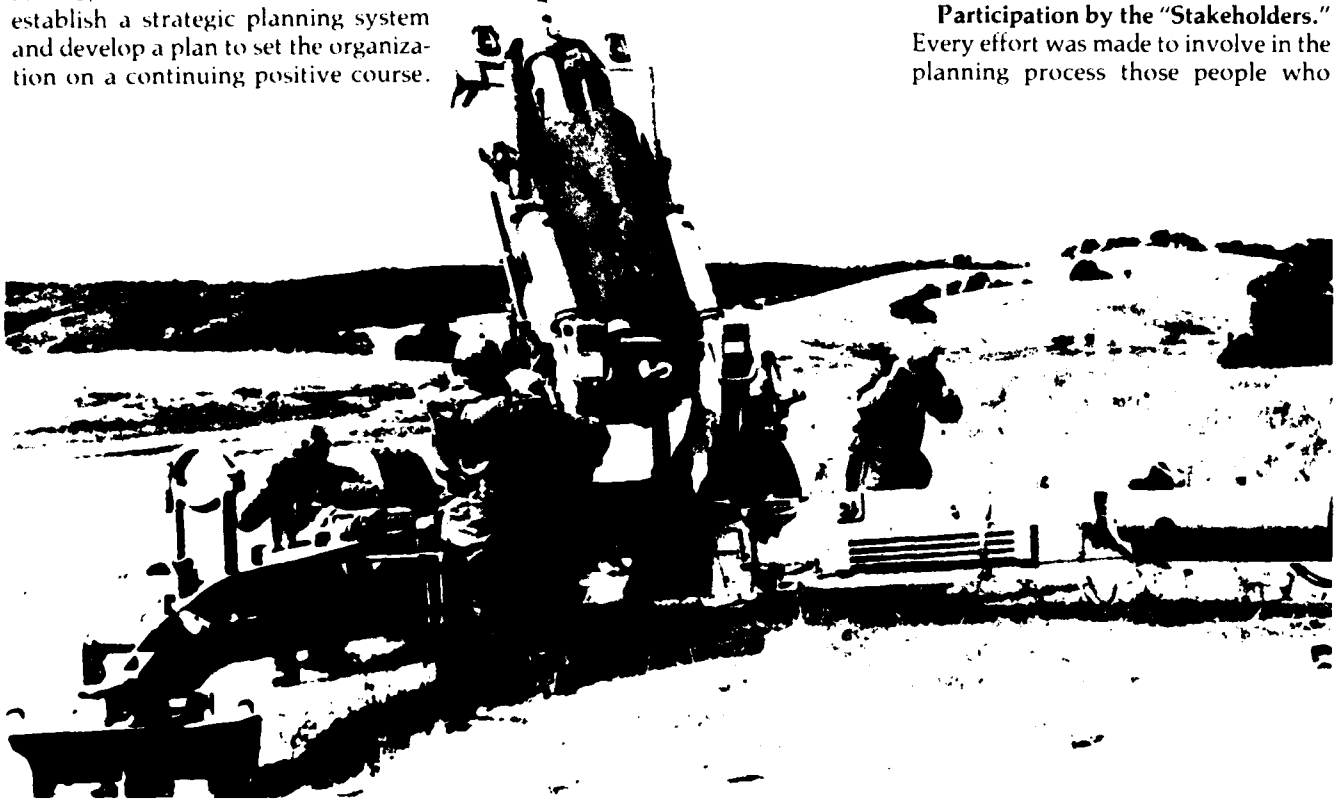
The Army wants 7,058 M1s by 1990. Production includes assembly of the turret and 120mm cannon, which replaces the 105mm gun.

Some of the previous reorganizations moved masses of scientists and engineers from facilities in other states to Picatinny and laid off elements of the old production-oriented workforce. These trauma caused serious identity problems and insecurities at all workforce levels. Though continuing to perform their mission, many of the employees experienced a malaise caused by the reorganizations, a sense of being hamstrung by the bureaucracy, and an erosion of technical job satisfaction as the "system" tended to place more and more technical work out on contract. Furthermore, it was no secret that the Army laboratories,

as a whole, were undergoing extremely close crutiny by the Department of Defense and the Army leadership relative to their productivity and worth to the taxpayer.

As part of a general effort to "up the organization," top management established in July 1983 a small team of hand-picked middle managers, all with significant line leadership experience, led by a seasoned senior manager. They would report only to the commander and the technical director of ARDC, and their first mission was to establish a strategic planning system and develop a plan to set the organization on a continuing positive course.

The 155mm M198 Howitzer firing the M712 Copperhead laser-guided artillery projectile is shown on the next page before impact with an M47 tank.



This team drew initially upon the strategic planning expertise of the DARCOM (now AMC) Long-Range Planning Office, the recent experience of the former ARRCOM Long-Range Planning Office, and the Organizational Effectiveness cells of their parent headquarters. They visited other DARCOM commodity commands, notably the Missile Command, the Aviation Command, and the Electronics Command to learn strategic planning in the unique government bureaucracy. They also took a formal textbook course in strategic planning to become familiar with the broader, generally business-oriented theory on the subject. This paper describes how ARDC institutionalized strategic planning. We hope that recounting the highlights of this process will provide useful information to similar organizations undergoing similar challenges.

Conceptual Framework

The ARDC Strategic Planning System was to involve two major activities, (1) building a comprehensive Strategic Plan, and (2) *bridging* that plan into *programmatic action*.

Key Considerations

Scope. This aspect was probably the most unique feature of the ARDC planning effort. In order to ensure that all the threads of the organization be properly considered, the commander directed that not only the traditional technical and fiscal issues appear in the plan, but also that *people*, *facilities*, and *management* considerations be fully integrated. Thus, we would be laying out future technical goals in full synchronization with arranging the money, talent, buildings, instruments, and management structures needed to achieve them. These five dimensions—technical, fiscal, people, facilities, and management would permeate every phase of the planning effort.

Participation by the "Stakeholders." Every effort was made to involve in the planning process those people who would hold a stake in the execution and realization of the plan. It had to be *their* plan in order to gain their commitment toward its fulfillment. Consequently, Center-level management insisted on active participation by the leaders of ARDC's subordinate functional elements.

Centralized Coordination and Sanctioning. The plan demanded some centralization in order to produce a coherent, coordinated and integrated course for ARDC. The elusive balance between encouraging creativity and initiative at the functional level, yet providing for a well-integrated plan, was achieved through a series of iterative

planning events occurring between the headquarters level and functional level. These were: top-down guidance, bottom-up initial strategy planning by subordinate elements, top-level consolidation and synthesis of subordinate element inputs, bottom-up final comment on the Center plan by subordinate elements, a final top-level revision, and sanction by the commander. (These items will be addressed in detail later in this paper.)

Time Continuum. To avoid the fate of many strategic plans, which is to be relegated to a back shelf soon after being written, top management stipulated that this would not be just a long-range plan. It would span the near-, mid-, and long-term out to 20 years. It would be an operational document for the near-term that could not be ignored. Considerable debate revolved about this point because of the practical challenges of combining a near-term operational plan with the more flexible, less clearly defined continuum of the mid- and long-term. The linkage was accomplished without serious difficulty through annexes to the plan which bridged into the planning, programming, budgeting, and execution system (PPBES).

Iteration. Since the plan had to be a living document, the system had to provide for a periodic updating and revision. We anticipate that with each iteration, given the feedback from the previous one, the plan will get better. An annual updating cycle was established for the key operational annexes; but, the main body was to be updated less frequently in order to provide some stability in direction for the organization. Here, a 2- or 3-year cycle was postulated.

Feedback. This point was stressed from the outset. It had two facets, (1) feedback as to *accomplishing* the plan, and (2) feedback as to the plan itself—its quality and content. With regard to plan accomplishment, measureable objectives and implementing tasks were established within the plan, and were used to assess progress toward achievement in a formal review and analysis process. With regard to quality and content, in addition to formal coordination during the plan's writing, a broad appeal was made to the entire workforce via the ARDC newspaper to read the plan critically, appraise its utility, and provide comments to the planning office. Feedback on the plan from external sources was solicited by briefing the plan to key actors in AMC and the more general Army leadership, particularly at TRACDOC. An ARDC Strategic Planning Council was established at 05 06 level with TRADOC, DCSRDA, DCSOPS, DCSLOG, and other organizations which strongly influence armament R&D. An industry-academic advisory council was organized to get the feedback of these two institutions on the projected ARDC technical program. Finally, informal mechanisms (such as personal contacts) for internal and external feedback on both the plan itself and its achievement were reinforced at all levels with the focus for this information being at the planning office.

The Driving Questions (and some answers)

The planning effort was based upon the concept of the "self-fulfilling prophesy." The organization built for itself a reasonable, very detailed and comprehensive picture of the future it desired. The "self-fulfilling prophesy" concept holds that this vivid picture, internalized by all, will help shape psychic and behavior patterns, and actually start to "make it happen" (a la Professor Maltz in his book, *Psycho-Cybernetics*). The portrayal of the future would be developed only after careful analysis of the current state of the organization and how the external environment could be expected to effect it. The plan would therefore systematically answer the following four critical questions:

—Where are we now?

—What will be the effect on us of the future external environment?

—Where do we want to be?

—How do we get there?

And each question would be analyzed in the five dimensions of technical, fiscal, people, facilities, and management.

The following elaborates on these critical questions and provides examples of ARDC's answers:

—**Where are we now?** This analysis engendered a very candid appraisal of the state-of-the-organization. The ARDC's strengths and weaknesses were presented in sharp relief. The problems mentioned in the introduction were surfaced, as were the significant strengths of the organization, most notably, the impressive talent and experience pool of the Center's 2,500 scientists and engineers.

—**Effect of future external environment?** The emphasis in this analysis was to identify threats and opportunities for the future. As the research, development and engineering center for one of the Army's major commodity commands, ARDC would continue to be subject to the influences and pressures of its position in the Army and Defense hierarchies. The Defense hierarchy, in turn, would be subject to domestic political influences to worldwide developments revolving largely around the actions and capabilities of our adversaries. Furthermore, ARDC would have to adapt to its local environment in terms of labor-force availability, prevailing attitudes in the local community toward Defense, and local dictates relative to environmental impacts of technical activity at the Center. Probably the most direct external impact on ARDC's technical future would result from the technological posture of future adversaries. Projected technical achievements of friends and allies would also require careful consideration.

An "environmental scan" was accomplished by study and discussion of a host of future-oriented documents, including *Megatrends*, Air-Land Battle 2000/Army 21, the Global 2000 Report to the President, the Soviet Battlefield Development Plan, the Army Plan, and the Army's Mission Area Analyses. The results of these analyses identified threats and opportunities leading to the following "strategic imperatives" for the armament community.

—Leap ahead of the threat—stop playing technical catchup always in a reactive mode.

—Arm a powerful light division while maintaining the strength of the heavy.

—Capitalize on U.S. technological strengths.

Alternative scenarios were considered for ARDC along the spectrum of conflict ranging from terrorism, through limited war, to all-out thermonuclear war. For purposes of this plan, the most likely adversarial environment was determined to be similar to what we were experiencing at the time. The analyses showed that ARDC could and should be a major contributor to reducing the risk of nuclear war by conceiving and developing, in partnership with private industry, more technologically superior *conventional* weapons for our troops.

Funding projections for the planning timeframe were critical to the plan's development. After some optimistic internal ARDC assessments which implied a significantly increased share of Army R&D and Procurement money going to ARDC, DARCOM headquarters suggested the following: Plan for realizing the levels of funding in the budget planning year and in the program objective memorandum (POM) through the 5-year POM timeframe. Limit funding projections for subsequent years to *one percent real growth*. Thus, the ARDC Strategic Plan was structured in a constrained fiscal environment, and although the softness of out-year funding projections was recognized, the plan presented a reasonable point of departure.

Analysis of demographic trends indicated that the talent pool of young, highly-trained engineers and scientists to replace the large numbers of experienced ARDC people becoming eligible for retirement would dwindle. Private industry, offering significantly higher starting salaries, would retain a recruiting advantage. This problem would be especially severe in those disciplines critical to ARDC's expanding future incorporating microelectronics into computer-driven weapons. All indications were that manpower constraints in the government workforce would continue to be severe. Thus, despite an expanded projected workload, the plan assumed no expansion of ARDC manpower in the

The squad automatic weapon is a man-portable, lightweight machine gun capable of delivering a heavy volume of fire up to a range of 800 meters.

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20-year planning timeframe. Emphasis had to be on strategies to enhance productivity within existing manpower ceilings.

Demographic analyses also showed a reduction in the military-age youth pool through the early 1990s. This increased the impetus for developing artificial intelligence and robotic weapon systems to reduce manpower requirements, particularly in the high-casualty forward areas.

—Where do we want to be? The collective judgment of ARDC managers projected a continuing major role for the organization in armaments and munitions. The goal was to achieve acceptance as the undisputed "center of excellence" in this field. Seven long-term technical thrusts were identified in the plan to focus technical activity toward the high-priority areas identified in the environmental scan, and to achieve a critical mass of resources, on fewer projects, if necessary. In keeping with the "self-fulfilling prophesy" idea, these thrusts were fleshed out with as much technical and fiscal detail as possible. Briefly summarized, they are:

Leap Ahead Artillery. Leaping ahead of Soviet cannon artillery systems through application of robotics and artificial intelligence, and through revolutionary new gun propulsion technology.

Smart Bullets. Greatly expanding smart bullets development to exploit technology even beyond the capabilities of Copperhead and similar systems.

The Light Division. Developing several light, powerful weapon systems for the Light Division.

Armament Enhancement Initiative. A classified initiative for close combat forces.

Ammunition Logistics. Improving ammunition packaging and resupply, a long under-emphasized area where application of new technology and streamlined management techniques can yield very high returns in overall combat effectiveness.

—**Mines, Countermines and Demolitions.** Using high technology sensors and warheads to optimize the "combat multiplier" potential of these relatively simple ways to shape the battlefield to our advantage.

—**The Individual Soldier.** The development of weapons for the individual soldier, including small arms, grenades, and other lightweight, man-portable ordnance.

With these overall technical beacons in sight, detailed programs with dollars, people, facilities, and management structures were laid out over the planning timeframe.

—**How do we get there?** The overall philosophy of how we get to our vision of the future was summarized in the following "Strategic Challenges":

—Develop and maintain a well-managed, competent, productive, and relevant workforce.

—Initiate and execute technical programs that lead to the fielding and support of armament systems which are responsive to the Army's mission needs, future operational concepts, and the state of technology.

—Develop and maintain suitable facilities that contribute to the satisfaction of the first two challenges.

The plan expanded upon these challenges and it established goals, objectives, and tasks to achieve them. Each task was tied to milestones and to specific managers responsible for their accomplishment. Eventually, the tasks would be incorporated into these managers' performance standards. Many of the tasks were relatively short-duration and oriented toward initiation of actions to accomplish major long-term objectives. Examples are development of a plan for automating all appropriate engineer workstations, and conducting a study to determine what portion of ARDC's mission should be executed in-house versus contractors. These goals and objectives were integrated into the goals and objectives of parent headquarters; and they were distributed to every manager and worker in ARDC as an annex to the Strategic Plan.

Bridge to Programmatic Action

The Strategic Planning Service provides for this vital link to reality via two major annexes to the Strategic Plan. The Tech Fiscal Annex lays out the projected technical program and anticipated dollars in a 20-year context. It describes the seven technical thrusts and then shows ARDC's projected technical contributions by Mission Area (e.g., fire support, close combat heavy, close combat light, etc.), and major weapon system (e.g., 155mm self-propelled howitzers) within each mission area. It depicts the full life-cycle panorama of armaments and munitions from early technology base activity through development and production, to engineering support after fielding. This document becomes the bridge to various AMC and Army planning documents to include the Army Long-Range Research Development and Acquisition Plan which feeds the POM, and the AMC Mission Area Materiel Plans (MAMPs). Perhaps more importantly, the Tech/Fiscal Annex is used to develop the presentations at the Center's annual DA/AMC/TRACDOC Reviews, and vice-versa.

The Mission Support Annex links with the AMC R&D Laboratory Facilities Modernization Plan and is used as a broad planning tool for annual personnel recruiting and training.

How to Set Up the System

The following is a brief "cookbook" on the specific steps to establish a strategic plan at the corporate level; that is, at the general-officer level in a service's R&D establishment.

—**Dedicate the Resources for Planning.** Like anything else, you don't get something for nothing. The ARDC found that at least during the first couple years of planning activity, in order to establish strategic planning against a host of competing priorities a dedicated team is necessary. The quality of the people on the team will be reflected in the quality of the plan. As with most organizations, ARDC already had a "planning" operation, but it was not oriented toward *strategic* planning. This function dealt with relatively near-team PPBES issues and had its hands full. Project managers dealing with armaments and munitions developed acquisition strategies reflecting the kind of comprehensive thinking required in strategic planning, but their charters were restricted to their own systems and usually looked at only the short- and mid-term. An organization like ARDC, which services many PMs, has the mission and the broader perspective necessary to make a rational plan for research and development of multiple interrelated weapon systems over a longer timeframe. Thus, a dedicated strategic planning team of four

Figure 1. Sample Strategic Planning Schedule

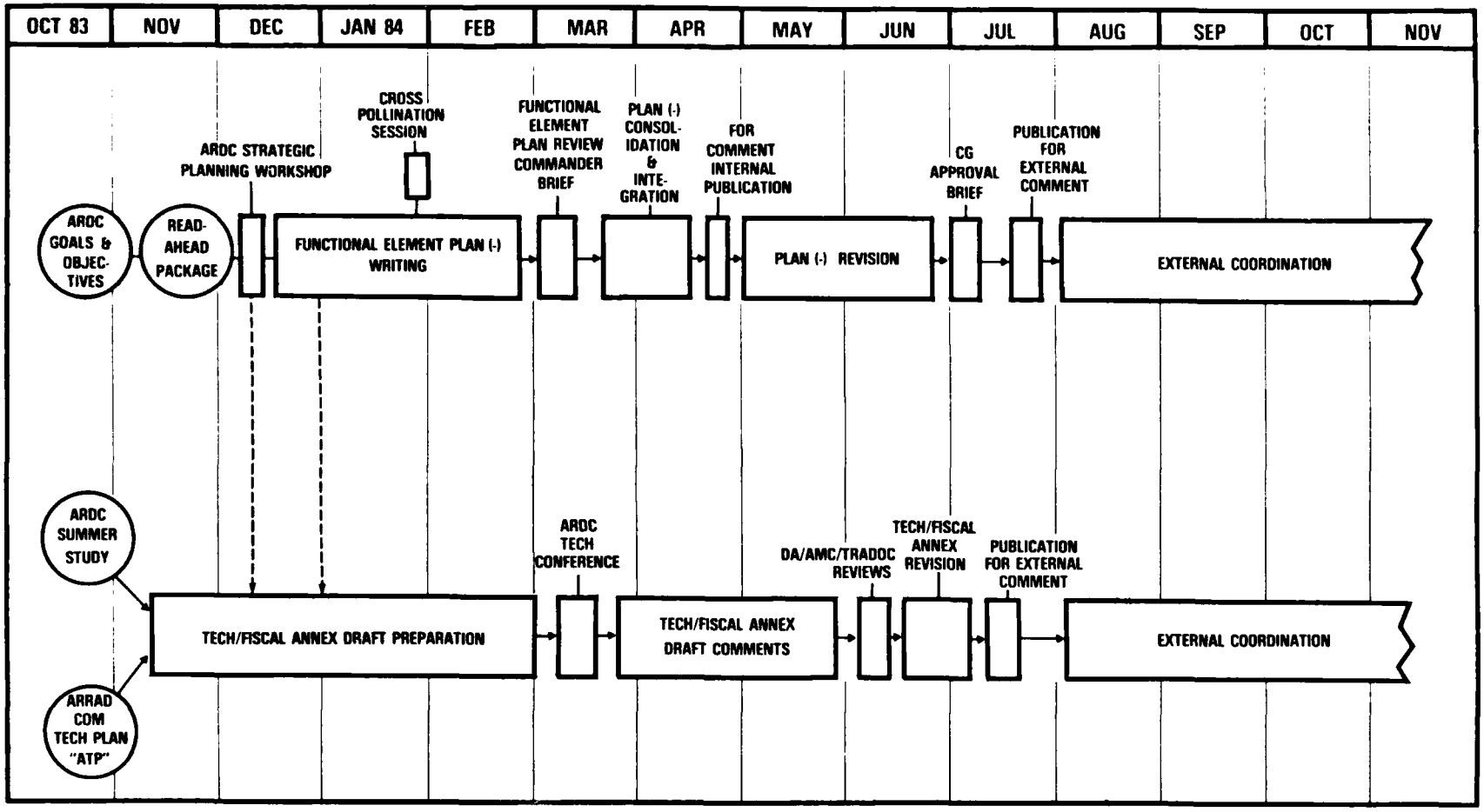


Figure 2. Strategic Planning Work Breakdown Structure (WBS)

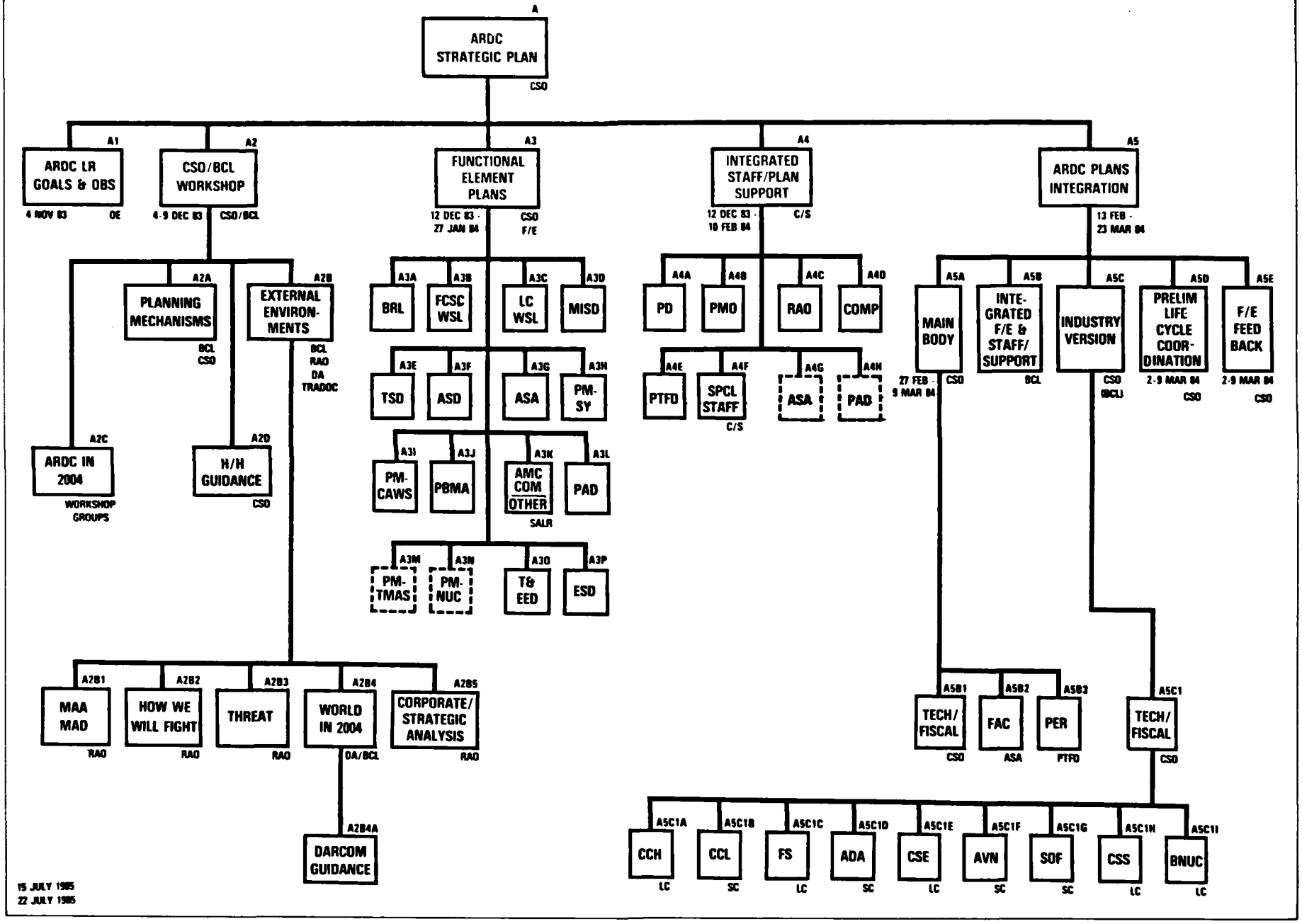
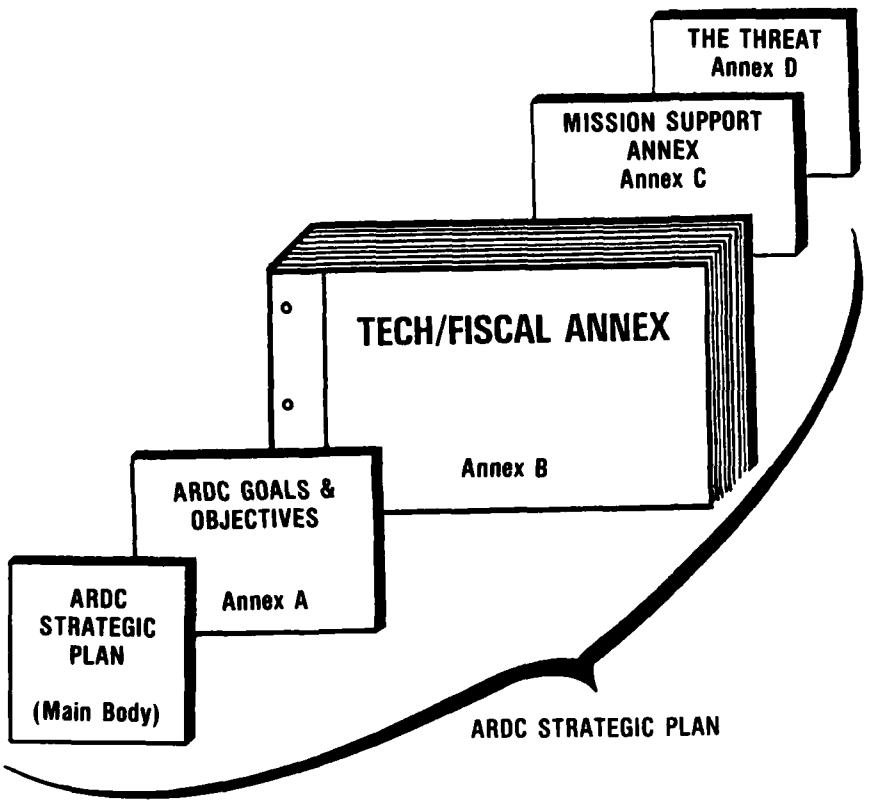


Figure 3. Sample Physical Structure for a Strategic Plan



people was formed at the ARDC headquarters level. It received adequate funding to travel extensively and to leverage its own efforts through outside assistance. Also, the 30 subordinate agencies of ARDC designated primary and secondary planning officers who were management-level people responsible for their organization's participation in and contribution to the planning process.

—**Get Some Outside Help.** Hire a quality contractor to assist in the planning effort. The ARDC hired an established think-tank with experience in strategic planning. Its role was to provide advice on certain mechanical aspects of strategic planning and an outside perspective for the organization. It also assisted in facilitating the planning seminars and in developing the initial draft of the plan. It is critical, however, to note that the *center literally wrote its own plan*. The contractor was a technical assistant in the process. This relationship was essential to fulfillment of the "stakeholder" concept mentioned previously.

—**Plan-to-Plan.** The generation of a strategic plan lends itself to a structured, scheduled, disciplined effort. A detailed schedule is useful, as is a work breakdown structure. Examples are shown at Figures 1 and 2, respectively.

The physical structure of the ARDC plan is shown in Figure 3. The main body of the plan is a 40-page document laying out the answers to the four driving questions. The Tech/Fiscal Annex projects the detailed technical mission. This Annex is organized into Part I (Technology Base), Part II (Development), and Part III (Production and Support). The Threat Annex describes the technical status of our potential adversaries and implications for ARDC. The Mission Support Annex addresses people and facilities. The Goals and Objectives Annex lays out the goals, objectives and implementing tasks for ARDC.

—**Get Top Management Support and Involvement.** This means not only at the corporate level, but also at the functional levels. This involvement can be precipitated in an initial top-level, goal-setting session, and reinforced through top-level participation in the milestone reviews of the plan, and in the final approval of the plan. At ARDC, the commander took a personal interest in the effort. He had the strategic planning group represented daily in command group meetings, and he personally participated in a series of briefings to inform the Army hierarchy of the plan's content.

The first goal setting session was a day-long affair in which the commander and leaders of major subordinate organizations took part. It took place away from the headquarters, and used common organizational effectiveness techniques. The goals of ARDC's parent headquarters, AMCCOM, were used as the point of departure for setting forth ARDC goals.

—**Kick-off With a Strategic Planning Workshop.** This workshop sets the tone for the nitty-gritty of the planning effort. In this 4-day session, the subordinate-level planners are educated on the external environment and are taught the necessary strategic planning skills. At ARDC they were presented a series of briefings on the future Threat (the Soviet Battlefield Development Plan), the Army Plan, the Army's concepts for how it plans to fight in the future, the technical implications of the Army's Mission Area Analyses and industry technological trends. These were followed by 2 days of extensive discussion and brainstorming on the implications of the external environment for ARDC, and on the initial top-management goals. The final day of the workshop was used to teach precisely who, what, where, when, and how each subordinate organization should conduct its planning effort. A formal packet of planning guidance, including all the workshop briefings, was issued to all participants. This included a sample strategic plan for a hypothetical subordinate organization (the "No Cal Laboratory") to be used as a planning template. The idea is to make the mechanics of the planning process as simple as possible and to show exactly what is expected of the planners, so that they can concentrate on the output.

—**Functional Elements Plan and Cross Pollinate.** Subordinate element planners then hold their own planning seminars for their own organizations, after which they draft their "first-cut" strategic plans. An important event in this process is the first "cross pollination" session, in which these planners

brief their organizations' draft plans to their peers, in order to coordinate them, modify them for coherency, and to capitalize on each other's good ideas. An ancillary benefit of this exchange is that the up-and-coming managers selected to represent their organizations become intimately familiar with the total fabric of the organization and its emerging goals, and begin to pull in the same direction.

—**Write, Coordinate, and Get Blessing.** After subordinate elements revise and complete their functional element plans, the leaders of these elements brief their peers and the commander. This assembly of top managers also benefits from the exchange as their subordinates had done 2 months earlier. The corporate-level planning office then consolidates and integrates the functional element plans into an overall plan for the Center. They provide drafts of this plan to the functional elements for comment. Revisions are made based on the comments and the final plan is briefed to the commander for approval.

—**Publish Widely.** Publication follows with the broadest possible dissemination consistent with security requirements. (Every ARDC employee was given copies of the unclassified parts of the plan.) Publication of the annexes is timed to correspond with the operative PPBES event. The Tech Fiscal Annex, for example, is published in draft prior to the DA AMC TRADOC Reviews in order to shape the Center's technical thinking in preparation for them. The final version is published after these reviews, benefiting from decisions made there. The Mission Support Annex is published in synchronization with the AMC R&D Laboratory Facilities Modernization Plan. The plan is formally integrated into the parent headquarters (AMCCOM) strategic plan. This completes one cycle of the planning process.

—**Coordinate with the User.** Coordination with the Army user community, as represented by TRADOC, is absolutely essential to the ultimate fulfillment of technical aspirations in the Tech Fiscal Annex.

Special emphasis must be placed on coordinating the various mission area segments with the respective TRADOC center; and the aim is to obtain the co-signature of the commander, ARDC, and the commander of each TRADOC center on each mission area chapter of the Tech/Fiscal Annex. Coordination with the DA staff is formally addressed through the Strategic Planning Council which meets twice yearly to review and comment on the plan. This coordination process provides graphical insight to the DA staff as to the impact of specific funding cuts on the total mosaic of armaments and munitions R&D.

—**The Industry Connection.** A balance had to be struck between the utility of making the relevant parts of the plan available to industry, in order to better harness their technical activity, versus keeping sensitive information properly guarded. The answer was an edited revision of the plan for industry consumption.

Conclusions

Some observations on the planning effort:

—**Is it worth it?** The cost of the first comprehensive strategic planning effort was about $500,000, including salaries of the planning office, the part-time commitments of functional element planners who invested an average of 3 weeks each, and the contractor support. In return, Center management at all levels executed its inherent planning responsibilities more comprehensively than ever before. The Center has its own comprehensive roadmap to the future with the active participation of the functional elements who will have to make it happen. Within ARDC there is now an unprecedented level of understanding of a common vision toward which ARDC's people can direct their collective physical and psychic energies. The workforce is sophisticated enough to know that the plan has very little likelihood of realization, *in toto*, but they also recognize that they now have something to shoot for and, with a little luck, they'll get at least part way there.

—**Was it presumptuous of RDC to lay out such a plan?** After all, shouldn't ARDC simply be responding to what the user says he needs for the future? What about "Concept Based Requirements?" Isn't there a danger of this government armaments technocracy perpetuating itself indefinitely, whether or not it is really contributing to national defense?

The ARDC engineers and scientists, working closely with the user community, are in a better position than any other agency to chart a recommended technical future for the Army's armaments and munitions. They can make best-informed projections of what the technology has to offer, based on a broad and unbiased view of the entire spectrum of relevant technologies. While ARDC must remain attuned to the Army's needs and "how-to-fight" concepts, there is a real two-way street between technology-driven fighting concepts and concepts-driven technology. The key to solving this riddle is close and constant communication between the user and the technical people; and the plan makes this easier.

The ARDC Plan should not become the Army plan for armaments and munitions. In fact, higher levels must integrate the suboptimized ARDC view with the broader perspectives available at Army-level; and ARDC will necessarily adopt these changes in the iterative nature of the planning process. But the plan, integrating technical goals and the resources and management structures to achieve them, is much less a danger in perpetuating an unnecessary technocracy than it is a positive catalyst for efficient, long-term use of taxpayer resources.

—**Flexibility Versus Capriciousness.** Like structural materials, planning systems that are too rigid, are likely to crack under external or internal stress. On the other hand, like structual materials, planning systems that are too pliant will lack the strength to accomplish their ultimate goals. The system at ARDC was designed for balance, but with perhaps a bias toward more rigidity and stability than had been perceived in the past. The flexibility card had been overplayed in that particular environment. Many say that a planning exercise is good for its own sake, simply because of the discipline and communications it forces on an organization. These benefits notwithstanding, the ARDC system was designed to be much more than an exercise. The intent is really to *make it happen*.

—**Many Suitable Approaches to Strategic Planning.** The approach presented here is only one way to perform this vital management function. There is certainly no guarantee that

(See Armaments, page 54)

SECOND PUBLICATION

Technical Management Activities Chart Update

Wilbur V. Arnold
Paul J. McIlvaine

When the first edition of the System Life Cycle Technical Activities Chart was published in the January-February 1984 *Program Manager*, comments were solicited in anticipation of updating it. General response to the chart was positive and copies appeared on the walls of many system acquisition practitioners. The purpose of this article is to release the second version of the chart (Figure 1) with a brief description of the update and some basic background for those who missed the earlier issue.

As a practical matter there are no technical differences between versions of the charts; the search has been for better methods to show the dynamic nature of the system acquisition process and the required interdisciplinary coordination. The first chart indicated that product definition is the common thread in system acquisition technical activity, but artificial divisions appeared for baselines, system engineering hardware, computer software peculiar system engineering activities, and cost considerations which seemed to separate them from that common thread. The new format broadens the system engineering process description to encompass the efforts that support product definition and provide tools for management of the activity. The remainder of the chart reflects the earlier format for test and evaluation, production management, and integrated logistics support with updates for current policy and thought.

Overview

Technical management is a broad term that includes the management of a totally integrated effort of system engineering, test and evaluation, production and logistics support over the system life cycle. The goal is to deploy (in a timely manner) and sustain an effective system that satisfies the need at an affordable cost (Figure 2). To achieve this goal, a program manager works to establish and maintain a balance among cost (acquisition and ownership), system effectiveness (in terms of the mission to be performed), and schedule.

The system life cycle consists of the interval from program initiation through system disposal. All activity in the acquisition process centers around the system equipment. Thus, the state of definition of the system configuration at any time in the system life cycle is an area of common interest among all disciplines. Phases in the defense systems life cycle are promulgated by the Department of Defense as concept exploration, demonstration validation, full-scale development, production, and operation and support.

Division of technical activities into functional areas of design, test, manufacture, and logistic support is convenient and usually results in a corresponding division of labor in a program office.

As can be seen from Figure 1, each of these functional areas is active in the earliest phase of the life cycle and continues through most of the program. The general thrust of technical management goes like this:

—*Define* what it takes to support, produce, and test the system utilizing analyses. Then see if we can afford it.

—*Influence the design* through producibilty engineering, logistics analysis, testabilty design, and design to cost. Develop specifications and translate requirements into contract language.

—*Prepare to execute* by arranging for the test facilities, acquiring and setting up the production line, designing and acquiring the logistic support.

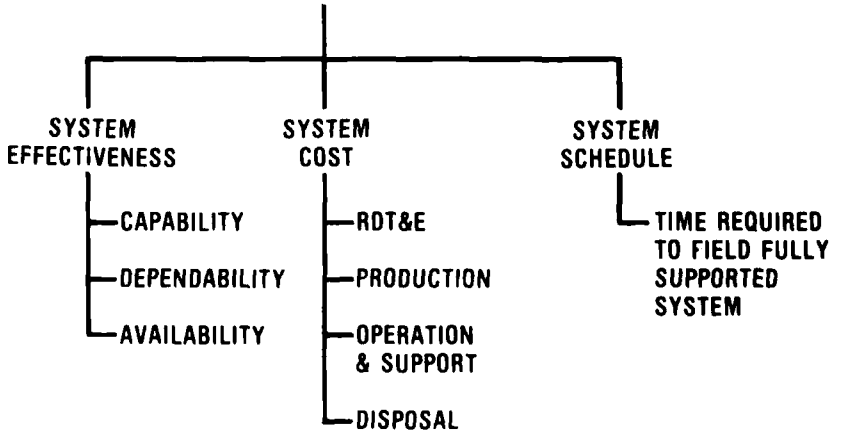
—*Execute* by testing, manufacturing, and supporting.

Figure 1 is a rigorous endeavor to show all the technical management activities in relative time phase. As such, it provides the manager a list of activities that should be accomplished and integrated in the various program phases.

Acquisition Life-Cycle Technical Activities

Technical activities are the genesis of a weapon system and continue throughout its life. Put another way,

Figure 2. A SUCCESSFUL PROGRAM



This chart has been designed for easy removal from Program Manager. Open staples to lift out section.

SYSTEM LIFE CYCLE TECHNICAL ACTIVITIES

PHASES IN THE L

NOMINAL TIME (IN YEARS) (0-2) (2-3)

SYSTEM ACQUISITION PHASES	PROGRAM INITIATION	CONCEPT EXPLORATION PHASE	CONCEPT SELECTION	DEMONSTRATION/ VALIDATION PHASE	PROGRAM GO AHEAD

PURPOSE OF PHASE

CONCEPTUAL STUDIES INVESTIGATION OF ALTERNATIVE SOLUTIONS
- DESIGN
- PRODUCTION
- LOGISTICS
- TEST

IDENTIFICATION AND ANALYSIS OF MAJOR SYSTEM ALTERNATIVES
- COMPETITIVE DEMONSTRATIONS

DESI SYST
- DES

DECISION POINTS

MS O (D)SARC (OPTIONAL) | MS I (D)SARC | MS II (D)SARC

STUDY CONTRACTS

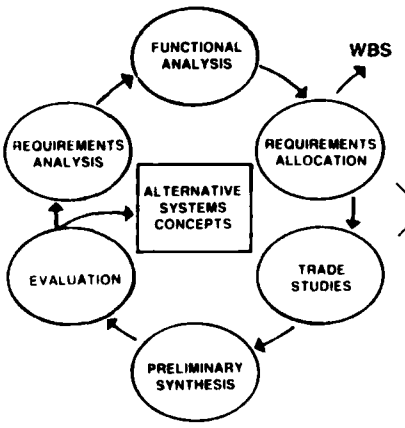
RFP SOW SPEC CDRL

D/V CONTRACT

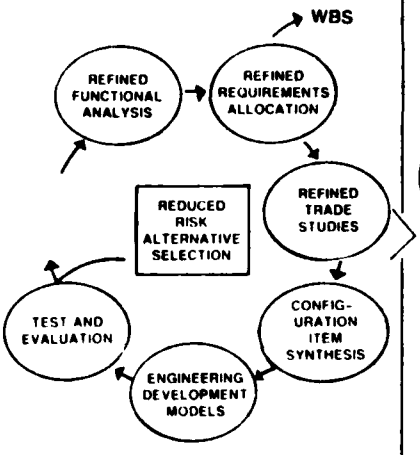
RFP SOW SPEC CDRL

SYSTEMS ENGINEERING

SYSTEM LEVEL



CONFIGURATION ITEM LEVEL



INTERD

SYSTEM ENGINEERING MANAGEMENT PLAN (SEMP)

PREPLANNED PRODUCT IMPROVEMENT (P^3I)

TECHNICAL ACTIVITIES

THE COMMON THREAD

SYSTEM (PRODUCT) DEFINITION

OPERATIONAL REQUIREMENT

REQUIREMENT REVALIDATED

REQUIREMENT REVALIDATED

TECHNICAL REQUIREMENTS FORMULATION

TYPE A SYSTEM S

REQUIREMENTS SCRUB

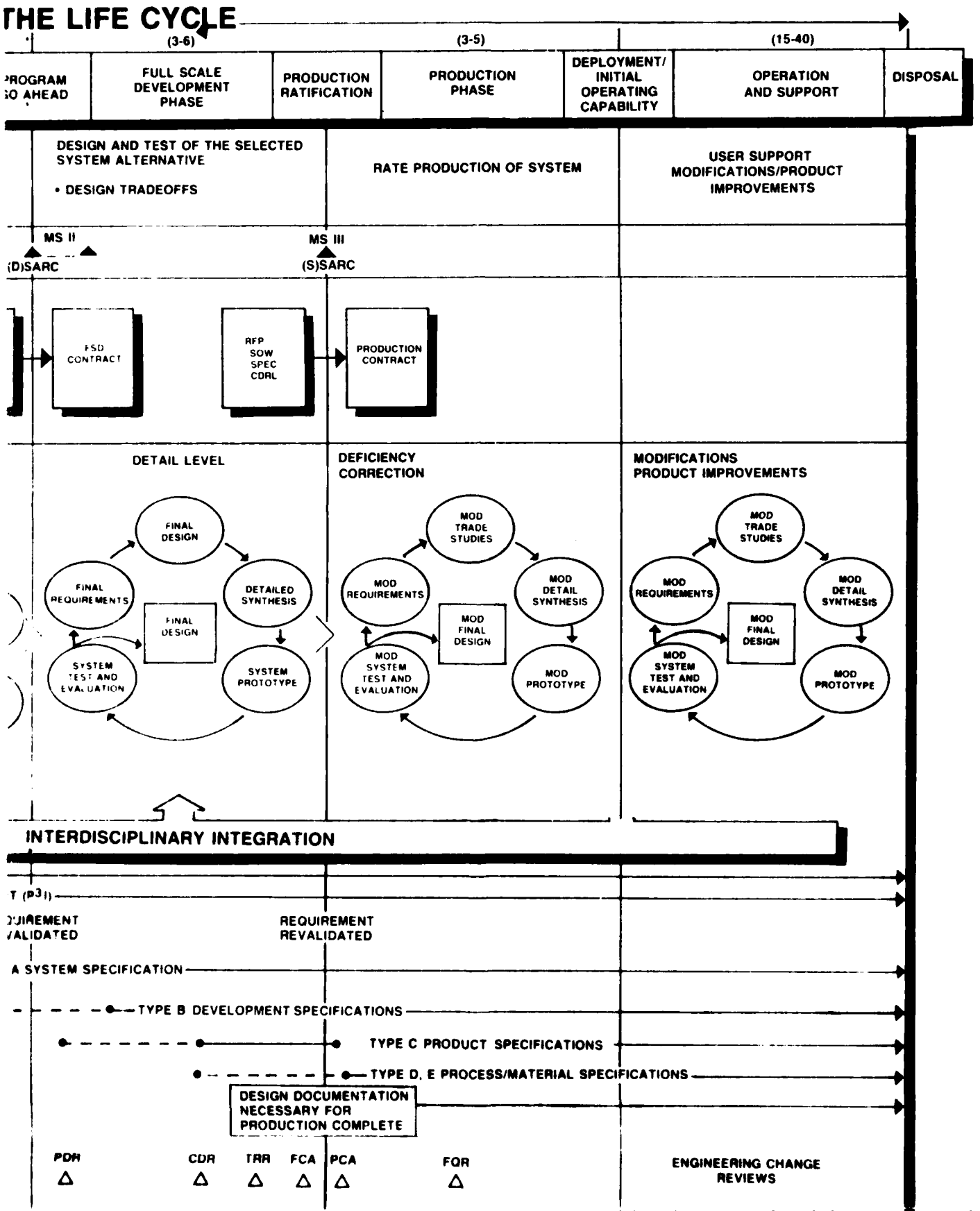
GAIN THOROUGH FAMILIARITY WITH THREAT AND OPS RQMTS

REASSESS THREAT

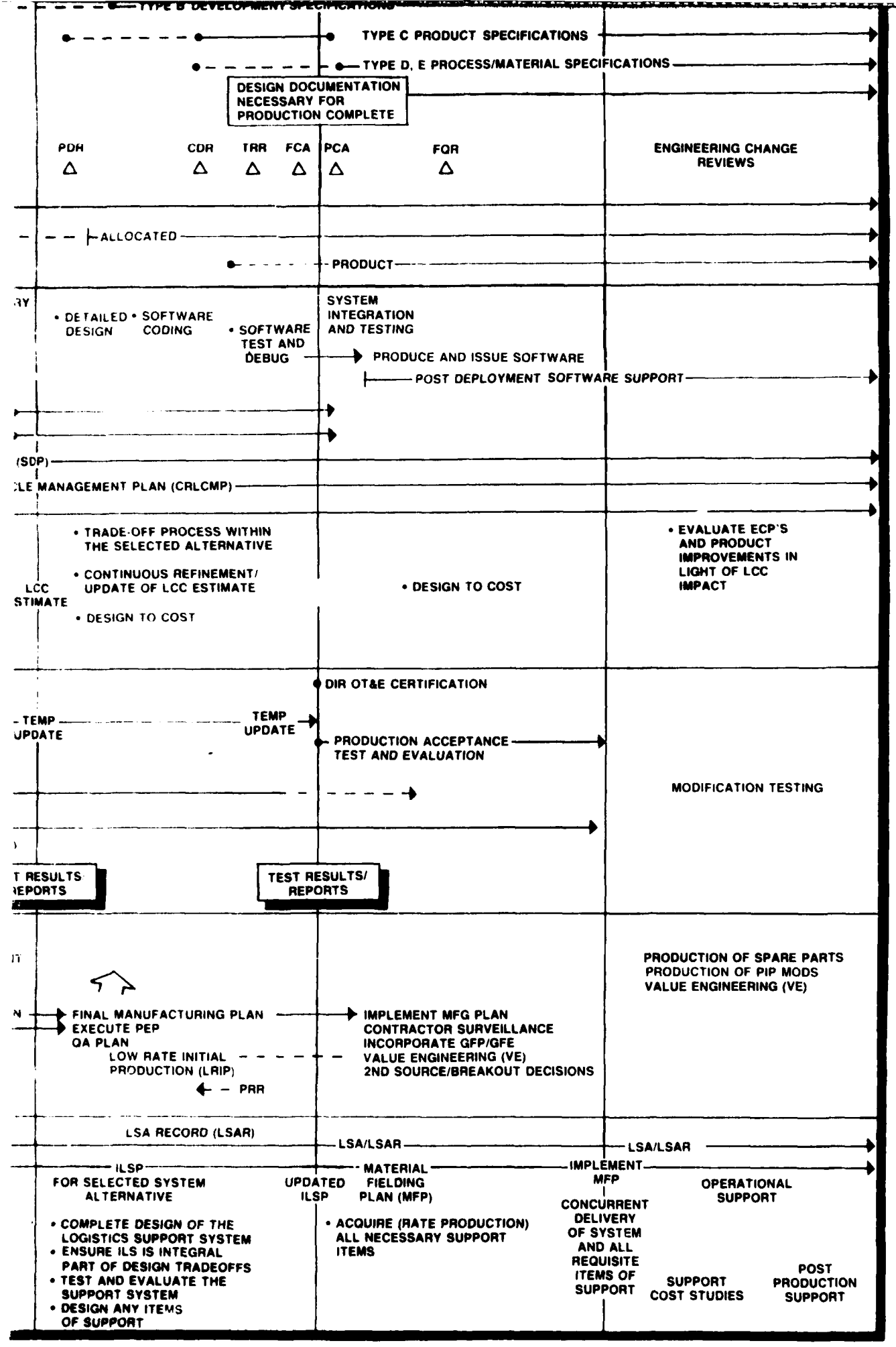
DESIGN REVIEWS AND AUDITS

SRR △ SDR △ SSR △ PDR △

(2)


THE LIFE CYCLE
(3-6)
(3-5)
(15-40)
PROGRAM GO AHEAD
FULL SCALE DEVELOPMENT PHASE
PRODUCTION RATIFICATION
PRODUCTION PHASE
DEPLOYMENT/ INITIAL OPERATING CAPABILITY
OPERATION AND SUPPORT
DISPOSAL
DESIGN AND TEST OF THE SELECTED SYSTEM ALTERNATIVE
• DESIGN TRADEOFFS
RATE PRODUCTION OF SYSTEM
USER SUPPORT MODIFICATIONS/PRODUCT IMPROVEMENTS
MS II
(D)SARC
MS III
(S)SARC
FSD CONTRACT
RFP SOW SPEC CDRL
PRODUCTION CONTRACT
DETAIL LEVEL
DEFICIENCY CORRECTION
MODIFICATIONS PRODUCT IMPROVEMENTS
FINAL DESIGN
FINAL REQUIREMENTS
DETAILED SYNTHESIS
FINAL DESIGN
SYSTEM TEST AND EVALUATION
SYSTEM PROTOTYPE
MOD TRADE STUDIES
MOD REQUIREMENTS
MOD DETAIL SYNTHESIS
MOD FINAL DESIGN
MOD SYSTEM TEST AND EVALUATION
MOD PROTOTYPE
INTERDISCIPLINARY INTEGRATION
REQUIREMENT REVALIDATED
A SYSTEM SPECIFICATION
TYPE B DEVELOPMENT SPECIFICATIONS
TYPE C PRODUCT SPECIFICATIONS
TYPE D, E PROCESS/MATERIAL SPECIFICATIONS
DESIGN DOCUMENTATION NECESSARY FOR PRODUCTION COMPLETE
PDR
CDR
TRR
FCA
PCA
FQR
ENGINEERING CHANGE REVIEWS

ALL INQUIRIES AND COMMENTS ON THIS CHART SHOULD BE ADDRESSED TO THE TECHNICAL MANAGEMENT DEPARTMENT, DEFENSE SYSTEMS MANAGEMENT COLLEGE, FORT BELVOIR, VIRGINIA 22060-5426.



DSMC CHART SE-T 1001

SYSTEM LIFE CYCLE TECHNICAL ACTIVITIES

INTRODUCTION

The past several decades have seen the rise of large, highly interactive defense systems that are often on the forward edge of technology. These systems have a natural process of evolution, or life cycle, in which actions taken or avoided in the very early stages can mean the difference between success and failure downstream. Acquisition of a system is a process that begins with the identification of a need. The goal of a system acquisition is to deploy (in a timely manner) and sustain an effective system that satisfies the need at an affordable cost.

The acquisition process consists of managing the technical activities by establishing and maintaining a balance among cost (the resources required to acquire, produce, operate & support, and dispose of a system), system effectiveness (the degree to which a system can be expected to achieve a set of specific mission requirements), and schedule.

FUNCTIONAL GLOSSARY

Contract - The document that definitizes the govenment/industry agreement.

RFP, SOW, SPEC, CDRL (Request for Proposal, Statement of Work, Specification, Contract Data Requirements List) - The documents used in letting contracts for each phase of work. The RFP sets forth the needs, the SOW is the formal statement of these needs as requirements for contractual effort, the specification sets forth the technical requirements and the CDRL definitizes the data deliverables.

I. Systems Engineering

System Engineering Management Plan (SEMP) - A formal document which includes plans and schedules for conduct of the product definition effort, the integration of design specialties, and operation of the contractor's Systems Engineering organization.

Preplanned Product Improvement (P^3I) - A deliberate decision delaying incorporation of a system capability but providing growth allocations for the capability.

A. Product Definition

Operational Requirement - Statement of the mission needs.

Technical Requirements Formulation - The process of converting operational requirements into technical requirements that can be acted on by designers.

Requirements Scrub - review of user/government comments received in response to announcement of an operational requirement. The scrub is used to validate and prioritize suggested/requested system functions/capabilities before release to industry. The technique may continue during the development process to address dynamic changes in requirements and technical capabilities.

Type A, B, C, D, E Specifications - See functional, allocated, and product baselines (I. C.).

B. Design Reviews & Audits

SRR - System Requirements Review - A formal review to ensure that system requirements have been completely and properly identified and that there is a mutual understanding between the government and contractor.

SDR - System Design Review - A formal review of the conceptual design of the system to establish its capability to satisfy requirements.

SSR - Software Specification Review - A formal review of specifications for computer software configuration items.

PDR - Preliminary Design Review - A formal review which confirms that the preliminiary design logically follows the SDR findings and meets the requirements, and results in approval to begin detail design.

CDR - Critical Design Review - A formal review to evaluate the completeness of the design and interfaces.

TRR - Test Readiness Review - A formal review of the contractor's readiness to begin testing computer software configuration items.

FCA - Functional Configuration Audit - A formal review which verifies that the actual item which represents the production configuration complies with the development specification.

PCA-Physical Configuration Audit - A formal review which establishes the product baseline as reflected in an early production configuration item.

FQR - Formal Qualification Review - a systems level configuration audit conducted after system testing is completed (to ensure performance requirements of the system specification have been met).

Engineering Change Reviews - Assessments of the impact of engineering or design changes.

C. Configuration Management Baselines

Functional Baseline - The technical portion of the program requirements (type A system specification); provides the basis for contracting and controlling the system design.

Allocated Baseline - (type B development specification) defines the performance requirements for each configuration item of the system.

Product Baseline (type C product specification) - established by the detailed design documentation for each configuration item. Normally includes:

Process baseline (type D spec) and
Material baseline (type E spec)

D. System Engineering (Software)

Software Policy Decisions - DoD Directives 5000.29 and 5000.31 reflect current DoD policies. Additional information is AR 1001-1 (Army), DoD-STD-2167 (Navy) and AFR 800-14 Vol I and II (USAF).

- HOL - High Order Language, Ada, is the required standard HOL for mission critical systems now under development.

- Standardization - Standardization applies at the language, instruction set architecture, and hardware level.

SDP - Software Development Plan - A management plan usually generated by the developer that covers the software development effort.

CRLCMP - Computer Resources Life Cycle Management Plan - Life cycle management plan developed by program managers and their management team.

IV&V - Independent Verification and Validation - and independent review of the software product for functional effectiveness and technical sufficiency.

SQA - Software Quality Assurance - The process of assuring that a software product is produced which performs properly, has minimum support requirements, and facilitates maintenance as specified.

Software System Requirements Definition - The analysis of user requirements to produce functional requirements for software at the A-Specification level.

Software Requirements Analysis and Allocation - The decomposition of the A-Specification requirements into functional requirements that are allocated to software at the B - specification level.

CSCI - Computer Software Configuration Item - The software element designated by the procuring agency for configuration management.

Software Design - The designing of the software systems to meet the functional requirements allocated in the B-Specification.

Software Coding - The coding (programming) of the software in accordance with the software design.

Software Test and Debug- The testing of the software to the functional requirements presented in the B-Specification.

System Integration and Testing - Integration of software and hardware, and testing against A and B - specification requirements.

Produce and Issue Software - Place or install software on appropriate medium (such as tape, disks, cartridge) for delivery and operational use.

Post Development Software Support - The post development process of updating software to fix errors, improve performance, meet new requirements or operate in new hardware.

System Engineering (Hardware) Activities for SRR, SDR, PDR, CDR, FCA/PCA, A Spec, B Spec, C Spec also apply to software.

E. COST

LCC - Life Cycle Cost - The total cost to the government for acquisition and ownership of the system over its full life.

DTC - Design to Cost - An Acquisition Management technique to achieve weapon system designs that meet stated cost requirements.

F. Test and Evaluation (T&E)

Test and Evaluation Master Plan (TEMP) - The top-level, summary test management document covering all phases of testing. Subsequent to its initial issue, the TEMP is updated at each at each major milestone or at any time there is a significant change to the test program.

Test Results/Reports - The conduct of testing and the associated collection reduction and analysis of test data continues throughout the acquisition life cycle. The issuance of formal test reports is typically aligned with the major

milestones to provide the essential risk reduction information and to support the program decisions.

Development Test and Evaluation (DT&E) is conducted to assist the engineering design and development process, define and delineate technical progress, and to verify attainment of specified technical performance. DT&E is the responsibility of the material developer.

Operational Test and Evaluation (OT&E) is conducted by the component's independent assessor to estimate a system's operational effectiveness and suitability, identify needed modifications, and provide information on tactics, doctrine, organization, and personnel requirements. OT&E can be subdivided into two phases not shown on the chart:

Initial Operational Test & Evaluation (IOT&E) - conducted before the production decision (MSIII) to provide a credible estimate for operational effectiveness and suitability of a system as close to a production configuration as possible, in an operationally realistic environment, by typical user personnel.

Follow on Test & Evaluation (FOT&E) - conducted on the deployed system to determine if operational effectiveness and suitability is, in fact, being attained.

Dir OT&E Certification. The report to the Secretary of Defense and to the Committees on Armed Services and on Appropriation of both the House and Senate which permits a major defense acquisition program to proceed beyond low rate initial production. The report covers the adequacy of the T&E performed and whether the effectiveness and combat suitability of the items are confirmed by the actual task.

Production Acceptance Test and Evaluation (PAT&E) - PAT&E is conducted on production items to demonstrate that those items meet the requirements and specifications of the procuring contracts or agreements. PAT&E is the responsibility of the material developing agency; however, the cognizant plant representative is usually tasked to support this effort.

Modification Testing - Modification testing is conducted during the deployment and O&S phases of the acquisition cycle on those items undergoing modification. Major emphasis is upon testing of the interface between the old and new, as well as logistics supportability.

G. Manufacturing

Evaluate Production Feasibility - assess the likelihood that a system design concept can be produced using existing manufacturing technology.

Assess Production Risks - estimate probabilities of success or failure in manufacturing.

Evaluate Manufacturing Technology (MANTECH) needs - discriminate manufacturing capabilities versus requirements to define new facilties and equipment needs.

Estimate Manufacturing Costs- develop resource estimates for manufacturing of [illegible] systems alternatives.

Design to Goals - desirable design parameters for the system.

Acquisition/Manufacturing Strategy - the approach to obtaining the total quantity of a system at some rate for some cost.

Resolve Production Risk - demonstrate required advances beyond the current capability.

Complete Manufacturing Technology Development - manufacturing technology is developed through a phased approach from definition to demonstration. This represents the final demonstration of the integrated manufacturing scheme.

Preliminary Manufacturing Plan - The description of a method for employing the facilities, tooling and personnel resources to produce the design.

Preliminary PEP - (Producibility, Engineering and Planning) - initial application of design and analysis techniques to reduce the potential manufacturing burden.

Industrial Base Issues - critical resources, skills and long lead materials and processes which are required by the system design.

P^3I - Preplanned Product Improvement - See Systems Engineering

Final Manufacturing Plan - The refined and formalized initial manufacturing plan.

Execute PEP - incorporate the producibility analysis into the mainstream design effort.

QA Plan - A plan to ensure conformance to requirements which includes quality of design and quality of conformance.

LRIP (Low Rate Initial Production) - low rate of output used to prove manufacturing technology and facilities at the beginning of production.

PRR (Production Readiness Review) - formal examination of a program to determine if the design of the product and the manufacturing process are ready for the production phase.

Contractor Surveillance - Verification of conformance to plans during production. Surveillance may be conducted by on site government representatives, authorized specialists, the program office or a combination.

Incorporate GFP/GFE - execution of contracts and management of items provided as government furnished property/government furnished equipment to the contractor.

Value Engineering (VE) - a program to allow for the sharing of cost savings derived from improvements in the manufacturing processes.

Second Source - execution of acquisition strategy to establish two producers for the part or system.

Breakout - execution of acquisition strategy to convert some parts or systems from contractor furnished to government furnished.

Production of Spare Parts- arrange for purchase of spare parts or a portion of normal production runs (see - ILS Post Production Support).

Production of PIP Mods - Manufacture of items which incorporate results of activities like product improvement program (PIP), P^3I, product modifications.

H. Integrated Logistics Support (ILS)

Develop ILS Strategy- Logistics acquisition strategy is developed setting forth objectives, resources, management assumptions, extent of competition, proposed contractural vehicles & program structure, but with emphasis on maintainability, maintenance approach, operational support patterns, constraints, contractor role, GFE, transition, warranties and post-production support.

ILS Alternatives/Trade-offs Assessments/Support Cost Studies - Largely consists of data gathering and modeling. Data comes from "Lessons Learned" files, comparative analysis, technological opportunities, use studies, field visits, standardization requirements, functional and military requirements, constraints, maintenance and operational approaches. Analyses and assessments are made on the cost and effectiveness of alternative support methodologies and supporting identified alternatives.

Draft Integrated Logistics Support Plan (ILSP) - The early logistics plan dealing with organizational authorities and responsibilities and containing broad logistics strategy, goals/thresholds, and maintenance concepts. Can also be referred to as a preliminary ILSP or ILS Management Plan (ILSMP)

Integrated Logistics Support Plan (ILSP) - The formal planning document for logistics support. It is kept current through the program life. It sets forth the plan for operational support, provides a detailed ILS program to fit with the overall program, provides decision-making bodies with necessary ILS information to make sound decisions in system development and production and provides the basis for ILS procurement packages-specifications RFPs, SOWs, source selection evaluation, terms and conditions, CDRLs.

Logistics Support Analysis (LSA) - A formal tool under MIL-STD-1388-1A that helps identify and tradeoff qualitative and quantitative logistics support requirements. It is a logical, documented basis from which to influence design and force a degree of requirements integration. It also provides a yard stick from which to assess logistics objective achievement.

Logistics Support Analysis Record (LSAR) - That portion of LSA documentation consisting of detailed data pertaining to the identification of logistic support resource requirements of a system/equipment. See MIL-STD-1388-2A for LSAR data element definitions.

Material Fielding Plan (MFP) - The plan to ensure smooth introduction of the system equipment to the user.

Post Production Support (PPS) - Systems management and support activities [illegible] to ensure continued attainment of system readiness objectives with [illegible] support after cessation of production of the end item [illegible] equipment).

product definition is the common technical thread of the system acquisition process; technical management is the control; system engineering is the process. The matrix in Figure 1 generally relates time to technical activities. The third dimension in managing this kind of effort is integration; that is, feedback and problem solving among activities, and planning for the future. Any one management output must be based on data and feedback developed during the generation of others. In other words, they must not only be consistent, but must also utilize the integrative power of functional consultation. The whole is greater than the sum of the parts.

There are some integration flows that run through the chart:

Phases are shown with nominal times, purpose, decision points, and general contract flow.

Systems engineering and related interdisciplinary integration tie together the progress of product definition through the phases—system level, configuration item level, detail level, deficiency correction, and modifications product improvements.

—Manufacturing and integrated logistics support influence the design and then proceed in a disciplined fashion to implement selected strategies.

—Test results provide feedback for analysis of performance progress.

Summary

Intense scrutiny of the system acquisition process continues. As program shortfalls are identified it becomes more evident that performing correctly at the start would have corrected most (if not all) of the deficiencies. This is much easier to write than do. External influences like budgets and schedules mandated by executive levels not controlled by the program office do have devastating effects on efficient management operations. This chart and the data and organization behind it should provide the technical manager with a tool useful in fighting for the necessary timely resources to operate the system acquisition process properly.

This is the second publication of the chart. It is intended for use in program offices and by others concerned with understanding the technical aspects of the system acquisition process. The content is oriented toward a large system procurement, but the flow of activity should be generally applicable to weapon systems. Comments are encouraged and should be directed to the authors at the publication address. Reproductions of the chart are available by writing Technical Management Chart, Defense Systems Management College, ATTN: SE-T, Fort Belvoir, Va. 22060-5426.■

■ *Mr. McIlvaine is director of the Technical Management Department at DSMC. Mr. Arnold is a professor of engineering management in the same department.*

INSIDE DSMC

People on the Move


Gillman


La Marca


Melton


Reuter


Tipper

Major David C. Gillman, USAF, is a professor of management development, Policy and Organization Management Department. He is a graduate of PMC 85-2 and has a B.S. degree in sociology and an M.S. degree in sociology psychology, both from Brigham Young University, and a J.D. degree (law) from the University of Arkansas.

Lieutentant Colonel Joseph A. La Marca, USAF, is a professor of behavorial science and a management consultant in the Policy and Organization Management Department. He is a graduate of PMC 85-2 and holds a B.A. degree in psychology from Louisiana State University, an M.A. degree from the University of Colorado, an M.B.A. degree from the University of Wyoming, a Ph.D from Louisiana State University, and is a D.P.A. candidate at the University of Southern California (Washington, D.C., Public Affairs Center).

Major David W. Melton, USAF, is a professor of financial management in the Business Management Department. He joined the faculty in April 1985 after serving at the Programs and Resources Office, Air Force Weapons Laboratory (AFWL), Kirtland Air Force Base, N.M. Major Melton received both his bachelor of arts degree and his M.B.A. degree from the University of New Mexico.

Major Robert D. Reuter, USA, is a professor of financial management in the Business Management Department. He attended PMC 85-2 and joined the DSMC faculty after graduating. Major Reuter holds a B.S.M.E. degree in mechanical engineering from Southern Methodist University and an M.S.B.A. degree from the University of Wyoming.

Mrs. Maryellen Tipper is a reference librarian in the Information Directorate. She came to DSMC from the Naval Intelligence Support Center, Suitland, Md., where she served in the processing department of the library. Mrs. Tipper received a B.S. degree from Oregon State University, and an M.L.S. degree from the University of Southern Mississippi.

Additions

Patricia Kennedy, library technician, Information Directorate.

Reflections of a Department of Defense Program Manager

(Based on a Composite Interview)

Wilbur D. Jones, Jr.

This article records a composite interview with the chief executive (program manager) of a generic weapon system program in the Department of Defense. The material presented is based on facts, opinions, and experiences. No military service, individual, or program is mentioned by name.

The time is 6 p.m. Friday. The boss, our program manager, returns to his office from morning briefings at the Pentagon after three hours of commercial flights to get back home. He missed lunch. His staff anxiously awaits word.

Not strong enough on technical issues and there's heavy concern over last month's tests," he says. "No matter how I justified things, they said it'll never fly for Monday's pitch to the Assistant Secretary. No other way; we'll have to do it over. I'm sorry, gang, but I've got to ask you to work tomorrow and maybe Sunday, too, until we get this thing put back together. Charlie, get me on a later flight to Washington Sunday night if you can. Somebody please call our graphics guy and alert him. And, will somebody make coffee and send out for food—any food!

Believe me, in my business which is program management in the Department of Defense, this scene is real. I've seen this situation before, and I know I'll probably have to live with it again. It's frustrating, and time consuming, but it goes with the territory—not only for me, but for my staff, support people, and contractors. Back to the drawing boards is characteristic. Trying to please a multitude of experts up the line and anticipate what the next minefield will look like is what I get paid for. I am going to get my weapon built, and built well, and out in the field to do its job. I am going to do everything I can to get the most defense possible for the taxpayers' dollars. But I'll tell you frankly: there are times when I wish everyone would just let me do my job and stop the changes, regulations, roller-coaster funding and—hey, hold on! I'm jumping the gun.

Actually, I'm here to introduce to you my recent interview with Program Manager, *the journal published bimonthly by the Defense Systems Management College. The editor, responding to the swirling tempest of today's acquisition environment, felt it was time for program managers to tell their story, to open up and get some things off their chests. The editor told me we need to let our friends, critics, and the public know what it is like to run a weapon system program, that we need to portray a week in the life of a program manager—challenges, pressures, constraints, pitfalls, and about the many who come to help. The editor said to talk about how a typical week affects us, our programs, people and efforts to get systems out where they're to be used. If it's possible to characterize a collection of impressions, opinions, and experiences as constituting something typical, the editor surely has tried through this interview.*

Why interview me? I was chosen to represent the hundreds of program managers in the Department of Defense. To illustrate, my program is called the "Generic Weapon System Program." It's everyman's program. How was I constituted? From information assimilated by faculty members of the Defense Systems Management College, and information from more than 20 interviews with program managers. These interviews included programs on the Selected Acquisition Report list, programs representing all phases of development and production, programs categorized as less than major, and from all four military services. Interviews were conducted in person and by the telephone, with some responses submitted in writing. These interviews, conducted in October 1985, supplemented first-hand knowledge of the current program manager climate which the DSMC faculty maintains on a regular basis. All program managers were asked the same questions. No scientific poll was taken and no data were quantified. Instead, program managers were encouraged to give impressions and opinions, to paint the picture as they see it.

My name? Well, just call me "Colonel." I am being questioned by the

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Program Manager, *journal of the Defense Systems Management College. Okay, I'm ready when you are.*

The Interview

Q: Colonel, welcome to Washington. I suppose you're hardly a stranger here. What brings you to the city this time?

COLONEL: You're right—I'm not a stranger. I really should buy a condo to use when I come here. Of all my road time, half of it is spent in Washington. This time it's Congress. The congressional committee on oversight has me testifying tommorrow morning.

Q: What's the subject?

COLONEL: The Competition in Contracting Act—CICA it's called—and how the contracting process works in DOD systems acquisition. This committee wants to expand the Act, make it even more restrictive, so I'm told. The OSD has testified. So has my service. Now they want to hear from the guy in the trenches.

Q: Just how are the CICA and all the recent procurement legislation impacting on you?

COLONEL: It hit us all at once, lots of new direction. We see it taking more time to get a contract awarded, to make a decision, longer administrative lead times. I believe Congress has overreacted. For example, we are being pressured to compete when it doesn't always make good management sense. The last couple of years has caused an overload of the contracting system—we are getting overwhelmed. The government is not staffed to do this. We have to watch each new law to ensure that implementation of one doesn't work at cross purposes with another.

Q: Weren't there adequate laws on the books already?

COLONEL: In my opinion, yes. Most laws are enacted to prevent something from happening again, something that didn't meet the spirit and intent of current law, or where someone found a loophole. If the services had implemented the previous laws properly, and held accountable the people involved through proper enforcement, then passing a new law should have been the last resort. I hope Congress is not expecting too much from us too quickly because most procurements on the street, like the ones that hit the newspapers, are under the old system.

Q: Surely you agree that the Congress has a right to act?

COLONEL: Of course. They have a responsibility to oversee how the Defense Department spends money, but I honestly believe they've gotten down to a very low level of detail. I appreciate their motivations to make things better. That's understood by people I talk with, including contractors and other PMs. The question of political motives influencing their decisions might be raised, but show me a service that doesn't have its own politics. So none of us is really immune. Congress is responsible to the people and that includes listening to the media, defense contractors, activists—you name it. Congressmen read headlines and horror stories about ashtrays and toilet seats and they react to pressures and concerns from the media and the home folks. Congress is human. They leave Washington and go home to face an environment that might make it tough for them to cut a deal with us. Like some of us in the PM business, they show cyclic tendencies to be cautious and risk averse. Our contractors are smart enough to see this. However, I wish Congress would spend more time on the big picture—the overall national defense policies, strategies and posture—and leave the acquisition details to professionals in DOD and industry.

Q: Do you find the current congressional role a roadblock or a help?

COLONEL: We get a lot of help from some members and some staffers. Without it, our programs probably would not survive. But, overall, it's the level of involvement that's causing discontent among many people in our acquisition community. However, Congress doesn't have a monopoly on what I'm about to say—it should be shared equally by OSD, service headquarters, and everyone up the line in a position of authority. But, congressional pressures seem to initiate much of the discontent.

Q: How so?

COLONEL: Micromanagement, plain and simple. In other terms, it's called second guessing, looking over my shoulder, getting into the grass, questioning everything—even before it's done—centralized decision-making, constant requests for information, and a penchant for details.

PM: You don't think this is within the authority of the Congress?

COLONEL: Of course the members and committees have constitutional rights on defense matters. No one disputes they are key players, and I wouldn't want to change that. But, there is this feeling that committees and their staffs who deal with defense acquisition matters are doing more than is necessary. Frankly, neither I nor my contractors can rationalize how a non-elected staffer can decide what my service should have for its weapons, or dictate to me how to run my program. Yet, they do it as a matter of course.

I suppose none of us wants to be told by people outside the technical side of program management whats best for us.

I know a PM who was told by a staffer: "Either you buy your item from another service's inventory or I'll see your program is cancelled." Here's a PM being told what his service must have to carry out its mission. If an industry bidder loses out, he doesn't always wait to file protests through channels—he can go right to a member or committee who gets the Subcommittee on Investigations or GAO into the act prematurely. I can understand how a member has to look out for hi district, but we wish protests would stay in the right channels. I believe, by and large we PMs are doing our jobs well. We have some darned good people running these programs who know their warfare area and what the user requires. I suppose none of us wants to be told by people outside the technical side of program management what's best for us.

Q: I would imagine most members and staffers have a good idea what's going on in acquisition.

COLONEL: Generally speaking, I agree. I wouldn't expect every one of them to be experts in all the details of our business, as much as they have to do. We realize there are some on the Hill who don't have a lot of experience or training in dealing with defense matters, and we try to assist them as best we can. But they often overextend themselves, causing us extra work or problems later. Just getting elected to office does not make yesterday's city councilman an expert on cruise missile guidance systems. We help them understand, provide them with data so decisions can be facilitated. For the most part we get along okay. It's not a we-they adversarial relationship. If the time and effort expended in this micromanagement was always, even mostly, productive we wouldn't be on such a soapbox.

I suggest DSMC conduct sessions for congressional members and staffs on how the acquisition process should work...

Q: Would education help toward a mutual understanding?

COLONEL: Yes, a lot. Most make a serious attempt to familiarize themselves with what is going on. But it sure hurts to see those who don't ending up on the evening news shooting at the Defense Department. There's a real need to educate those who must deal with DOD. And, let me add quickly, it works both ways. It's amazing how many of our acquisition people are just not checked out in how Congress operates and how Washington exists. I would love to see a major effort here, a mutual one, as you said. In fact, DSMC is a perfect vehicle to coordinate this. I suggest DSMC conduct some sessions for members and staffs on how the acquisition process should work, and do whatever it can to get PMs up to speed on good congressional relations.

Q: For the time being, do you see anything on the horizon to improve relations between the Congress and the acquisition community?

COLONEL: There are rays of light. I see great value in the recent Goldwater-Nunn report, particularly regarding micromanagement and level of detail. I would gladly testify before a committee that is biased toward understanding our problems and working in partnership with us, rather than at us. The Senate Acquisition Subcommittee hearings on these very subjects might come up with some proposed changes. We'll work with them.

Q: Do you see more, rather than less, congressional involvement in the future?

COLONEL: More, until it runs its course. There is a strong pulling on the reins of centralization, not only from Congress but by OSD and the services as well. It's easy to see that defense is a big target in these days of budget deficits. Until the coffeepots and dog-kennel fascinations subside, meaning either DOD cleans up its act or the people lose interest, it will continue.

Q: Don't some feel DOD has asked for a lot of this?

COLONEL: True, I believe we in DOD over the years have not been serious enough about minding the store. Congress perceived inactivity or unwillingness to buckle down to get at the heart of the matter and took the only steps available: do our job for us. The DOD has taken important steps to remedy the situation in the last few years, and I think we're headed in the right direction. At least we recognize there are serious problems. Maybe we, too, are overreacting and laying on additional restrictions. Wheels turn very slowly in this town. Policy enacted by a stroke of a pen, like the Carlucci Initiatives in 1981, takes time. Only now are we really beginning to feel much impact. So what happens? We can't wait for the system to find itself and go our way, so we reverse gears impatiently and turn back toward centralization. My boss worries about our systems commander. He worries about the Service Secretary, who worries about SECDEF, who must face Congress. That's where much of it starts.

Q: Back to the Congress again. You feel strongly about congressional relationship with the acquisition process, don't you?

COLONEL: Yes I do. They have every right to believe they are doing their job, exerting their influence and power as the legislative branch. As we know, this muscle flexing really gained a head of steam 12-13 years ago. I understand all this. Again, I'm looking for more of a partnership role from the Hill.

Q: Is it just the micromanagement of details that bothers you?

COLONEL: No. It's really their overall preoccupation with telling us what to do, period. Not only from legislation, but from the language of congressional reports, committee hearings, authorization and appropriations bills—all these and more—Congress tells DOD how many to buy and where to buy them. Some of this guidance can bust the service position or planning. And then DOD plays games, often badly. The annual base closing lists and gold watches just invite understandable political responses.

Q: Do you think the Congress sees you unfit for your job?

COLONEL: Not unfit, just perhaps a little bit suspect. Their push for the revolving-door restriction to prohibit us from taking certain jobs when we leave the military is seen by PMs as such indication. In my mind, there is some distrust on the Hill of both PMs and contractors, that we are out to get the government and the taxpayers. In light of isolated incidents, the ones with front-page appeal such as the famous dog-kennel story, they would clamp down excruciatingly hard on what are allowable costs under a contract. Has anyone figured out the time and cost to administer these checks and crosschecks of the process? Would we be swimming in overhead? Has anyone applied the Newtonian principle that with every action there is an equal and opposite reaction? The reaction here would be increased costs and slowdowns. Another thing of importance: My contractors are walking on eggs. Contractor management must sign up to and assume legal responsibility for

all activities of their underlings. They can go to jail for the mistakes of underlings. I don't think shifting total responsibility to a single senior management level will solve the problem and is bad for the morale and the success of my program. It's also a smack at their patriotism.

Q: Are you defending the contractor's point of view?

COLONEL: I have my problems with contractors, many of which are unrelated to what Congress does; for example, getting the contractor to stand totally behind his product and have him cover the cost of correcting defects. My program's extended warranty problem has consumed a major portion of my staff time and all my contractor PM's time for 6 months, an overriding problem. I am having difficulty getting the contractor to focus on anything else. I want to talk more about warranties later. For now, I have to try to understand where my contractor is coming from. If I don't get a timely response from him, I can attest our policies are changing so fast that now virtually every decision must be taken to the company president for concurrence before they will even discuss it with me. My contractors are so uncertain over what I will break out, compete, demand NTEs for, demand extra contractual coverage for, that it slows us down and is detrimental to our program. Then I get called up to the 3-star or the committee staff to explain why there are delays.

Q: Will the Congressional Oversight Committee call industry to testify?

COLONEL: I certainly hope so. They deserve their day in court.

Q: Let's talk some more about the shoe being on our foot. What else is DOD doing wrong?

COLONEL: First, after legislation is enacted, as if it alone isn't restrictive enough, our people beginning with the lawyers get out the magnifying glasses. Between them and the contracts people, the restrictions become tighter, the maneuvering room smaller, and the PMs' hands are further tied. We in government no longer are creative. We no longer apply that common sense we used to. We seem to have lost the will to make things work within the system. We must have a rule that applies to every possibility. Instead of making things worse, we should try to work within the law to do the job. Second, there is the way we handle the budget process. Congress just has to do something about this whole federal government budget mess, but that's another day. We in DOD shoot ourselves in the foot and cause many of our own stretchouts and funding problems. The frequent "what-if" drills are unsettling, not to mention their possible numbing or "crying wolf" effect. What-if budget exercises often start from disparate sources without coordination. Timely release of funds would help tremendously. The way money deals are struck in smoke-filled rooms off-line is poor business practice.

Q: Now you're really getting deep into the budget situation, aren't you?

COLONEL: Yes, because money is the mother's milk of weapons acquisition. Sometimes we never tell Congress the same story twice, especially on funding numbers. Do we actually try to confuse the Hill? Who is the real bookkeeper? I've been stationed in Washington off and on for 7 years, and in and out on business for another 5 or 6, and sometimes I consider it a tossup on who runs the Defense Department. You make the choice: the budgeteers or the contracting people. But, I guess we'd both have to say the money people, for without their calculators and spread sheets there would be no contracts to ensnarl the bureaucratic maze.

Q: This bureaucratic maze—how has that changed, if at all?

COLONEL: Let me tell you how awful it's become. Staffs are layered beyond belief. Each layer wants information right away. Everyone gets into my area, or tries. Requests from higher authority, by the time they reach me, have been massaged by so many hands the original intent might be lost. To get to the top I must pass judiciously through countless wickets. My briefings are changed at every level. Do you realize there actually are people making careers as information gatherers? Anyone in a decision loop can give guidance and cause me to respond. Requirement validity is frequently challenged. I go through 10 or 12 prebriefs before I can get a major decision. No one wants to be surprised. Inexperience in a program management office, or in the field in a warfare area, or in acquisition seems to be the trend in today's staffs. I'm talking about staffs from OSD right down to those of my boss' boss. It's so bad I can't talk to Secretariat folks without having systems-command types on hand or giving permission.

Q: That would bother you, wouldn't it?

COLONEL: It's been building over the years. Maybe it's the promotion systems pressures or that we have overstaffed the military with paper-pushers and managers and not enough leaders. What I know is I have a charter from my Service Secretary as a PM, but in effect I am without authority to act. These ultimate managers lacking technical know-how need a 100 percent analysis for an 80 percent solution. There is a shortage of decision-makers with fortitude to stand by their decisions without waffling or changing course.

There is a shortage of decision-makers with fortitude to stand by their decisions without waffling or changing course.

Q: Wouldn't you see all this as an honest attempt to get all of the facts before committing large sums of money?

COLONEL: Then why have a program manager? Why not do it by *ad hoc* committee, with one person doing technical things, another finding the money, another out listening to briefings or giving them, and then maybe someone else to be a Monday-morning quarterback for all. There has to be a better way, and the PMs are dying to be a part of making it happen.

Q: Putting it that way, the committee system would fail. Someone would have to invent the PM system if it didn't exist, right?

COLONEL: I want you to say that, and I am giving you cause. What I also want is for the system to produce more doers and less checkers. In my case, there are 10 times more people checking the work than doing it. It should be: Tell me the rules, let me do my job, and if I don't, fire me. Stop giving guidance and making decisions if you don't appreciate the consequences. I spend a lot of time cleaning up the battlefield.

Q: You hit hard on briefings and information exercises. Can you tell me more?

Tell me the rules, let me do my job, and if I don't, fire me....Stop giving guidance and making decisions if you don't appreciate the consequence.

COLONEL: In one service, it takes a PM at least 23 briefs to get to DSARC. In another service, it takes about 11 months lead time just to get to that service's SARC—and that's on the way to DSARC, mind you. I spend about 40 percent of my time giving or working on briefings and reviews and responding to requests for information from higher authority. Some of the hardest working people in my command are the graphics folks who do vugraphs and help us put together the fancy presentations we take on the road. Much of this is triggered by Congress. But in my experience of several years in a PMO, while congressional interest is always high, there are times when the temperature is turned up or down. I know a PM whose program is in concept exploration, and he made about 15 visits to the Hill last month. If my program is in the SARC cycle or calls for scheduled reviews, I make more briefs. Another PM tells me he's due for seven major briefs within the next ten days.

Q: Incredible. Many people in acquisition have no idea about this use of your time, do they?

COLONEL: Probably not. Because a big part of my job is selling, maybe I could have better prepared myself for this job had I taken one of those weekend crash courses in positive thinking and dynamic salesmanship. I am constantly having to sell my program, keep it alive. I must show I believe in it, and always justify it—justify the need, funding, design, acquisition strategy, schedule, contractor's overhead, and so on. It's unfortunate, but some programs live real well or barely—few ever die—primarily on the basis of the PM's ability to pitch his program from a podium to a room full of stars. He's expected to have all the answers in a Roman coliseum setting, but he's not around his office long enough to get them. He's usually out briefing.

Q: You spoke a lot about being on the road, or away from your office. What kind of travel schedule do you have?

COLONEL: Extensive. I have to keep up with things. I don't know any PM who's able to catch all his kids' birthdays each year. I'd say 50 percent of my total time is spent on the road. By this I mean, out of the office, whether in the next building pitching or in Europe. And listen, I guarantee not all my travel has that glamorous weekend in London or Hong Kong. Some of my contractors—I work as closely as I can with both primes and subs—have plants or offices all over the place. If the Norwegian government wants me in Narvik in the middle of January in connection with a weapon agreement, I go to Narvik in January. As I indicated earlier, about half my road time is in the Washington, D.C., area, then maybe 30 percent at contractor facilities, and the other 20 percent with my users in the field or at test ranges, conferences, etc. I know one PM who must travel 80 percent of the time—he's really Mr. Outside. Besides mastering the art of pitchmanship, a PM must develop a knack for doing office work, or snoozing, while standing in an airport ticket line. I make tons of calls back to the office because many things can't wait until I return. My staff keeps me well informed but, like any executive, I have to deal with many diverse matters on the phone, many very serious, while someone is tugging on my sleeve to catch a plane or get back to a meeting with the company president.

Q: I can see where you would become frustrated after circulating about carrying one set of guidelines, only to return to the office and find they've been changed. Correct?

COLONEL: The PM and PMO are on a leash.

Q: Let's get back to laws, regulations, and directives under which you operate. Are any burdensome?

COLONEL: There are so many I think they're about ready to gridlock.

Q: Could you be more specific?

COLONEL: Competition hits me the hardest. CICA, as we got into earlier, doesn't leave me maneuvering room for exceptions. Mandatory competition for its sake is restrictive and sometimes handcuffing. It is a costly alternative to good management, and we will probably find our costs of doing business rising in order to comply. The upshot is it places accountability ahead of efficiency. Everyone is covering their tracks by the book at the expense of common sense, good business practices, and good management judgment. After DOD and the services give their own competition proclamations, the level of detail is excessive. Most PMs were already competing when we felt it was right. By making it tough to go sole source, we run the risk of losing the expertise of a previous contractor as well as lengthening the contracting process. But look, it's the law, and my staff and I are doing what we have to do to adjust and make it work.

Q: Earlier you had mentioned warranties. What are they?

COLONEL: They are called guarantees by Congress. Every PM wants his weapon system to perform and be free from defects. But why impose such controls on us, making it mandatory? For the most part, contractors usually have covered their products if something went wrong. It's easy to throw general shibboleths at both toasters and fighter aircraft and get people to agree. The arguments against warranties have been aired enough already but, again, let me state I understand why Congress acted. Now, what about the cost? Does industry warrant for nothing? There are many

good intentions in this and other issues; but (1) are they necessary, and (2) what is the end result: Will we have a better defense weapon system for the least amount of dollars?

Q: Isn't what you just said really the bottom line for everything we are trying to do in weapons acquisition?

COLONEL: Absolutely. The decision-makers and others in Washington have to understand the needs of the guy in the field and of his commander. Without their requirements, there would be no need for weapons. Is this radar going to find the missiles headed for the carrier battlegroup and allow us to destroy them in time? Is this tank configured for crew comfort and ease of operation? Is this the least expensive way to get the weapon in the hands of that marine so he can do his job in battle?

Q: When we talked on the phone to schedule this interview, you mentioned staffing problems. Would you elaborate?

COLONEL: This is a real shifting of gears, but I welcome the chance to discuss it. Mine are probably personnel problems in a broad sense. I don't know a PM who doesn't have them in some fashion. There are several things that hurt. One is lack of qualified and capable people who will work in a PMO. Another is the unbelievably cumbersome federal civilian personnel system and the length of time it takes to advertise, interview, hire, and get someone on board. Third is the fact that most services won't dedicate enough military and civilians to a PMO *per se*, forcing us to use matrix organizations for functional support. Each of these is a killer at one time or another and draws the attention of a PM trying to manage his program, or whatever is on the front burner.

Q: Why are these situations unique to a PMO?

COLONEL: In the first case, PMO hours and pressures are tough. We know it's hard to keep real good engineers, logisticians, and financial people in government. Military people perceive a need to move around and punch tickets for promotion. The matrix matter, while appearing to be the way most systems commands are going, fosters more second guessing and review, especially when they are not integral to my office. Why, I've got matrix support types telling me to coordinate or they won't do what they are supposed to. They don't report to me. I don't write their performance evaluations. I get their help when it's convenient to them. In a small PMO, you wait on their schedule. Is this cost effective? Probably so to the systems command. Efficient? It all depends on the personality and professionalism of the matrix staffer himself. Again, I must sell myself, my people, and my program just to get my due help from the technocrat next door. Hey, it always boils down to people. If you don't have the horses, you can't keep up with the race.

Q: Can we touch on more of the front-burner issues that affect you?

COLONEL: Let me list them and elaborate as necessary. *Multiyear procurement* is a biggie. We wish we could do more. The approval process is an obstacle. The annual procurement process ties us down. Our program is now stable and should qualify for multiyear. *Component breakout*—On my last program we were in production. Our system worked and was in deployment. The price of components and spares went up. We were told to break out and go competitive. We reintroduced risk into an otherwise successful and completed program. Whatever savings accrued may not have been worth the cost and effort to handle integration of the new parts. Recompeting all piece parts after source selection is risky. *Program stability*—My current program has come out of a terribly unstable period when funding perturbations—we were zeroed out before I got here—and stretch-outs, descoping, and reorienting drove us bananas. Two were at fault: Service HQ couldn't make up its mind how badly it wanted the system, and Congress wasn't about to commit bucks as long as the service cogitated. Talk about off-line dealings. I lost a lot of sleep. Too, instability is caused by turnover at the top. Today's golden-boy program can be tomorrow's forgotten relative when your 3-star gets transferred. *Advanced technology*—Believe it or not, it's hard to keep up with state of the art, much harder to keep tabs on what the future will bring. *Data rights*—We shouldn't have to require complete data package rights on all programs and should have the authority to waive them as necessary. *Nunn-McCurdy reporting requirements*—That kind of thing just means more reports to Congress and the world that cost us overhead. It's more visibility for someone to shoot at.

Q: From your experience in a PMO, do you feel you are more or less restricted than you were a few years ago, and why?

COLONEL: More. No doubt about it. In my 5 years in program management I've seen an increase in micromanagement by all levels above the PMO.

There is congressional legislation ...headquarters tweaking, continuous explaining, selling, and justifying.... PMs have less authority...that is the tragedy of the times.

This is much more restrictive, as I've mentioned. There is congressional involvement, legislation—additional, that is, for none goes away—headquarters tweaking, continuous explaining, selling, and justifying. We can't plan as well and are always re-doing. The PMs have less latitude and less authority, and that is the tragedy of the times. I had more responsibility with capability to act when I was an 0-3 years ago than I now have as a colonel. I am accountable, but lack freedom to manage or lead. My contractors' PMs are in the same boat. There are more required briefings and reviews. Many people up the line appear more skeptical, afraid of someone below them making that mistake that will affect their careers. Decision points have been elevated.

Q: Is this trend out of control?

COLONEL: The restrictions won't end soon. The FY-86 Authorization Act talked about revolving doors—this one really hits home, in the pocketbook.

The Authorization Act also included restrictions and guidelines on should-cost methodology, allowable costs, and more. I believe this is the tip of the iceberg.

Q: Go ahead. I haven't finished talking about all of the restrictions, have you?

COLONEL: Thank you. I may as well get them out. The bureaucracy of the contracting process has worsened and poor contract management is hardly unusual. The constant budget perturbations impact badly on my obligations and expenditures. I lack the flexibility to change a system once it's adopted by higher authority, even if it's wrong. Maybe we're headed back to total-package procurement. Internal service disagreements become public quickly and complicate rational understanding of the basic problems. Just getting someone in HQ to tell me exactly what they want me to build for them, or to sign up to anything controversial, is often like pulling teeth. If the Pentagon is interested in a program, you can bet that's where the decisions will be made, if not in Congress. These are all frustrations to the PM.

I've done my homework, roadwork and spadework....I try to keep everybody informed...and give everybody the same, and correct, information.

Q: Even with this picture showing the down side your program is in pretty good shape, isn't it?

COLONEL: Yes—knock on wood. I've been able to recruit a good staff. As things go, most parts are clicking. I've done my homework, roadwork, and spadework—that's what it takes. I try to keep everybody informed and, most of all, give everybody the same, and correct, information. I hold my breath every day and hope for sunshine, and make plans for when it rains.

Q: What are your top priorities?

COLONEL: First and foremost, to protect my money. I do everything I can through networking and official channels to learn what's happening to the bucks. I'm always at the ready. Second, I answer the loudest voice in the chain of command. Then, it's whatever is today's fire drill, or whose wheel squeaks the most. If it's coming from a friend on the Hill or OSD or HQ, they'll get instant attention. Probably my first priority should be the contracting process. But these are facts of life.

Q: You mean managing your program comes after all this?

COLONEL: Did I forget to say that managing the program is important, but must take a back seat sometimes?

Q: What are some of the other things that eat away at your time?

COLONEL: I spend a lot of time reacting to someone else's schedule and not to my own. I'd say I'm normally in a response mode, and that's bad. It's bad for me personally, because like most PMs I'm a take-charge guy who wants to lead rather than follow. It's bad for the program because I honestly believe that leads to procrastinations by everybody and is one big reason why it takes so long to get a system built. Here's how I handle media inquiries. I say I'll be glad to talk with them but first they must clear it with public affairs in the Secretariat, or whoever, and by the time it is cleared, I'm no longer in the picture. This may not be right, but it causes me less stress. Besides, the media seem to scare most military people. We in DOD acquisition have never learned to work with or use the media to our advantage. Here's another area where someone like DSMC could help us. I'm also forced to get more personally involved in contract negotiations, mods, warranties, MOUs, etc., than I used to. We feel compelled to watch every comma and period. It's caused procurement to look more like a tennis match. I play when I can, so I watch the volleys; PM shop serves, procurement office returns after a couple of months, then HQ bounces it around and serves it back to the PMO and we smack it again. It usually requires a tie-breaker to determine the outcome—it's that close. I also spend a lot of time checking on personnel requisitions, spares procurement actions, lost items in the depot or on major installations, missed shipping dates, serving on some board or panel, making configuration decisions, preparing RFPs, or chasing down matrix specialists to get something done. Then I worry a lot.

Q: Worry? Pardon me for smiling this way, but why don't you delegate that to your deputy?

COLONEL: Say, do you know how valuable a deputy program manager is when the PM is on the road half the time? Who do you think interacts with the 3-star? Who do you think answers a controller's question at 4 p.m. on Friday? Or meets for 4 hours with beancounters in the Pentagon to resurrect a cool $50 million in RDT&E? Who takes the chewing out, or gives it, or threatens the contractors, or suffers when we learn our GFE is going to be one month late at the integrator's; or listens patiently to a delegation from the user pleading for one more bell or one more whistle? Thank goodness I have a deputy who can handle it. He's our inside man working the internal problems, interfacing with the technicians, and knows where things are buried. Why should I make him do my worrying?

Q: What can be done to remove or lessen the micromanagement and layering? Didn't one service recently delete a 4-star overlay acquisition command to streamline?

COLONEL: That 4-star command went away in name only, from what I know. There are still the competition advocate, specifications advocate, reliability experts, contracting experts; all the folks still micromanage their own views, not necessarily the written rules, into whatever they touch. Now the systems' commanders report to both Secretariat and HQ, serving two masters. As people thought might happen, the folks in the Pentagon have signaled the possibility of more guidance and instructions and more centralization. I think what the service did is good for the long haul. But for the time being, the PMs ask: "What changed?"

Q: What kind of hours do you put into your job?

COLONEL: I average 12 hours per workday on the job. Plus, there's normally one or two weekends each month where I work half or all day

(See Reflections, page 54)

Why Engineers and Scientists Often Fail as Managers

(And What to Do About It)

Owen C. Gadeken

Tom, a young engineer with a bright future in manufacturing, couldn't believe his company had disapproved his idea for automating the manufacturing department. How could they not see the savings and increased efficiency that would result? So, Tom redoubled his efforts, armed himself with more facts, and confronted his company's executives who knew little about computers. The result—they not only rejected Tom's proposal but promoted someone else in his place. And, to make matters worse, the new director promptly installed the computer system initially recommended by Tom.[1]

Gene, a scientist working in an Air Force laboratory, combined hard work with creative insight. When contract efforts failed to develop a new organic polymer, Gene came up with the formula by working nights and weekends in his garage laboratory. His invention saved the Air Force several million dollars, and he was apparently on his way to a management position in the laboratory. Unfortunately, the opportunity proved to be short-lived. Gene was given more important projects to manage, but every time he had a briefing to give to laboratory top managers, he panicked and his supervisor had to fill in. Gene continued to work as a researcher and eventually retired from his original position.

Do engineers and scientists make good managers? These real stories (the names have been changed) indicate that moving from technical specialist to manager may not be an easy transition. To help you understand why, I will review what we know about engineers and scientists who move into management. I will summarize studies that have compared technical managers with managers in general. Then, I will conclude with a discussion of how the Defense Systems Management College (DSMC) is adjusting its curricula to cope with the challenge of better preparing DOD engineers and scientists for careers in systems acquisition management.

DSMC is adjusting its curricula to cope with the challenge of preparing DOD engineers and scientists for careers in systems acquisition management.

Background

Career patterns for science and engineering graduates in the United States have been found to follow two general pathways.[2,3,4] The first path of this "dual ladder" is increasingly responsible positions in their technical disciplines which require little administrative or supervisory responsibility. The second path is a transition from their technical specialty into administration and/or supervision, perhaps starting as a technical manager of a team or project but often moving on to general management positions within their organizations.

Many studies have been done comparing the two paths in the dual ladder and most show greater organizational rewards for the managerial path. Thompson, Bowden, and Prive[5] found that engineers believe that better performance will result in their promotions into management positions. Alden found "that for all engineers in

all employment groups, the median salary for those in supervisory positions was 33 percent higher than for non-supervisory personnel."[6]

In 1973, the Engineer's Joint Council conducted a study concerning the increase in supervisory responsibility of engineers as a function of their age. The results appear in Table 1. Note that by age 40, two-thirds of the engineers surveyed held supervisory or managerial positions.

In 1981, Purdue University conducted a national survey of engineers from nine major engineering societies and engineering graduates from eight major universities and colleges. Completed surveys were returned by 2,852 engineers representing approximately 50 percent of the original sample. Figure 1 is a graph of the percentage of respondents supervising professional or managerial personnel plotted as a function of years since receiving their bachelor's degrees. Men tended to have greater supervisory responsibility over time than did women. However, these results do show an equally pronounced shift to management for both men and women as was shown in the Engineers' Joint Council Survey.

Now that we know engineers and scientists do transition in increasing numbers into management as their careers progress, the next questions is: How effectively do they make the transition and perform as managers? In other words, do engineers and scientists have the characteristics which suit them for careers in management? This is a very important but complicated question since it requires characterization of both effective technical accomplishment and effective managerial accomplishment. At this point, I will discuss each of these areas separately before looking at research results that compare and contrast technical and managerial characteristics.

Characteristics of Effective Engineers and Scientists

The most fundamental research work on characteristics that leads to technical achievement for scientists and engineers has been done during the last 30 years by the Institute for Social Research at the University of Michigan. I will use this section to summarize the results of these studies which have been documented in *Scientists in Organizations* by Pelz and Andrews.[9] They studied 1,300 scientists and engineers from varied organizations including five industrial laboratories, five government laboratories, and seven departments in a major university.

Each participant's level of achievement was determined from the following measures: scientific or technical contribution to the field in the past 5 years (as judged by a panel of colleagues), overall contribution to the organization (also as judged by colleagues), number of professional papers published in the past 5 years (for engineers, number of patents or patent applications was used), and number of unpublished reports in the same period.[10]

Organizational climate characteristics were measured using a carefully tested questionnaire and were correlated with the above achievement data to find out under what conditions scientists and engineers performed at higher and lower levels.

Pelz and Andrews' overall conclusion from their research was that scientific achievement was characterized by a number of paradoxes. Their insightful explanation for their results was that scientists and engineers peformed best when conditons leading to security coexisted with factors creating challenge. The authors borrowed the term "creative tensions" from Thomas Kuhn[11] to characterize these effective dichotomies. The major "creative tensions" are summarized in Table 2.[12]

Characteristics of Effective Managers

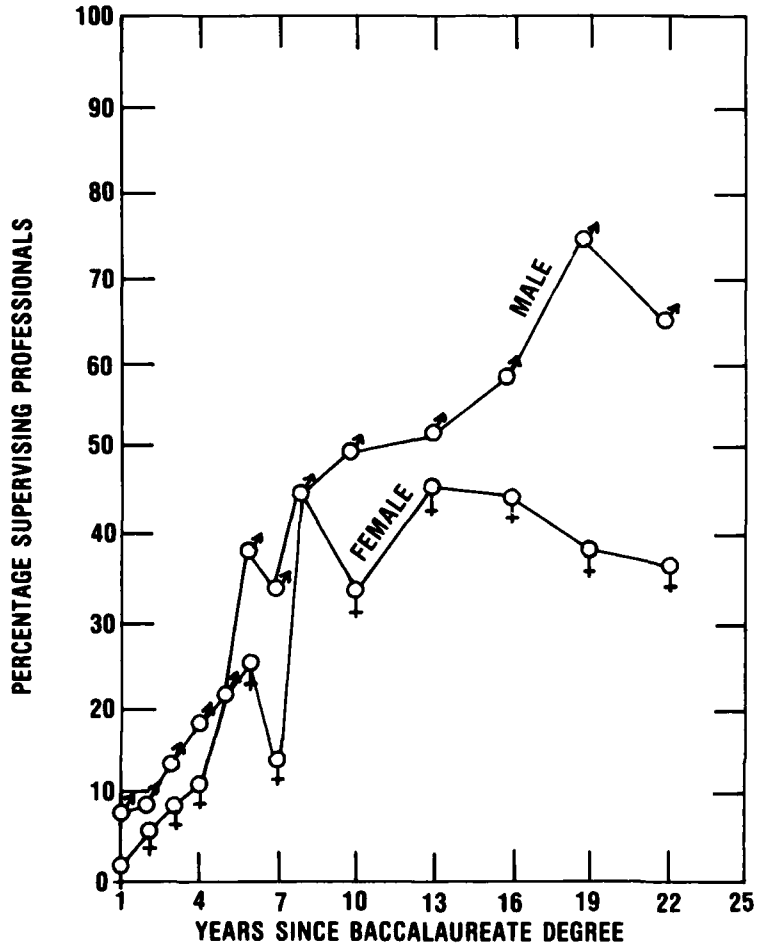
This topic probably has been the subject of more research studies than any other in the field of management. Most of the early research was based on the trait theory which suggested there were certain inherent personal qualities that were essential for effective leaders or managers. If these qualities could be identified and measured, then we should be able to find and develop managers and leaders early in their careers. This theory obviously conflicted with the commonly held view which said that most people could be trained to assume leadership and managerial positions in their organizations.[13] Fortunately, results of trait-theory research have been inconclusive. "Fifty years of study have failed to produce one personality trait or set of qualities that can be used to discriminate leaders and non-leaders."[14]

Even though this statement was made in 1961, current research has been equally inconclusive. In a recent study, Dr. Harrison Gough of the Institute of Personality Assessment and Research at the University of California, Berkeley, tried to correlate a managerial potential scale developed from the California Psychological Inventory with performance of a sample of 200 Air Force officers. A composite performance index was developed from the officers' effectiveness reports, interviews with each man's superior officer, and the mean ratings given by three different promotion review boards. Although significant at the

Table 1. Supervisory Responsibility of Engineers as a Function of Age[3]

Age	None	Indirect	Project	Mgt Resp.	Total
25-30	37%	25%	31%	7%	=100%
30-35	22%	21%	41%	16%	=100%
35-40	16%	18%	41%	25%	=100%
40-45	10%	16%	36%	37%	=100%
45-50	13%	15%	32%	40%	=100%
50-55	13%	16%	29%	42%	=100%
55-60	13%	17%	27%	43%	=100%
60-65	17%	16%	25%	42%	=100%

Figure 1. Percentage of Men and Women Engineers Supervising Professional or Managerial Personnel by Years Since Obtaining Degrees.[8]



0.05 level, correlation of the managerial potential scale with the officers' actual performance was only 0.20.[15]

Current research on managerial effectiveness supports a situational or contingency theory of management. Briefly stated, this theory supports variation in managerial behavior to fit the organization and the environment. One group of research results which supports such a contingency theory are studies by Lawrence and Lorsch[16] and later by Lorsch and Morse[17] at Harvard University's Graduate School of Business Administration. Research by Fielder[18] and Tannenbaum and Schmidt[19] also supports the contingency approach. The contingency model of leadership effectiveness developed by Lorsch and Morse is illustrated in Table 3. All of the above authors note that a leader's actual style is closely tied to his personality but suggest that leadership training may be useful in making managers more aware of their own styles and helping them adjust their behavior, within their own range, to fit the demands of the situation. Another observation is the potential usefulness of the contingency model of leadership for better personnel selection based on congruence with organizational and environmental characteristics.[21]

A very similar situational leadership theory also was developed by Hershey and Blanchard.[22] They evolved their theory from Ohio State University's leadership quadrants[23] and Blake and Mouton's managerial grid.[24] Their theory, depicted in Figure 2, attempts to match the style of the leader with the maturity of the followers (subordinates). In the theory, each leadership style is determined by some combination of task and relationship behaviors. Task behavior is characterized by defining what, where, when, and how tasks are to be accomplished while relationship behavior involves communication and emotional support among leaders and followers. Maturity of workers involves two factors: (a) ability (competence) and (b) willingness (motivation) to do a given task. Low-maturity individuals are neither willing nor able to take responsibility for a task while high-maturity individuals are both willing and able to take responsibility.[25]

Comparisons of Engineers and Managers

From the previous discussions, it should be clear that comparison of personal competency factors between the two groups is not particularly valid because of the significant effects of both organizational and environmental characteristics suggested by currently accepted contingency/situational theories. Nonetheless, I still found some research studies that provide interesting insights into differences between engineers, engineering-trained managers, and non-engineering-trained managers.

A study by Brown, Grant, and Patton[26] used the California Psychological Inventory (CPI) to differentiate between engineers, engineering-trained managers, and non-engineering-trained managers from three high-technology engineering and manufacturing companies located in northern Utah. The sample consisted of 71 male employees. Due to the relatively small sample size, the number of CPI scales was limited to the following seven:

1. Ai Achievement via Independence
2. Ac Achievement via Conformance
3. Do Dominance
4. Cs Capacity for Status
5. Sy Sociability
6. Py Psychological Mindedness
7. Sp Social Presence

Multivariate analysis of variance was used to analyze the differences between the three groups. A complex combination of five of the factors was

Table 2. Contingency Model of Leadership Effectiveness[20]

	SECURITY	CHALLENGE
Orientation	------	Effective scientists and engineers were active across the spectrum of research, development, and application.
Freedom	Effective scientists placed a high value on freedom...	But they also conferred with their colleagues more often.
Specialization	For younger scientists, performance improved with length of time spent on one main project...	...but performance was also higher if they had several skills and avoided narrow specialization.
(cont'd)	For mature scientists, performance increased with self-confidence and interest in probing deeply into an area.	...but high performance was also linked to mapping broad features of new areas.
Organizational Climate	In departments with minimum coordination, autonomous scientists were ineffective.	More effective were scientists with broader stimulation from both external and internal sources.
(cont'd)	In departments with tighter coordination, autonomous scientists were most effective since they could work independently...	...but were focused more on important problems faced by the organization.
Influence	Ph.Ds and engineers were most effective when they could influence their decision-makers...	...but were also more effective when their goals were influenced by several others in their organization.
Work Group Simularity	The most effective scientists reported personal harmony in their work groups.	...but intellectual stimulation.
Age	Performance peaked at mid-career...	...*but could be sustained by self-confidence*, interest in breadth as well as depth, and periodic project rotation.

Table 3. Contingency Model of Leadership Effectiveness[20]

A Contingency Approach to Leadership

Appropriate leadership behavior	External environment	Internal environment	Subordinate's personality predispositions
Directive-boss centered (Task oriented)	Certain and programmable	Controlling and tight and few expectations about participation	Low need for independence; Low tolerance for ambiguity Little knowledge of, and information about the work
↑ Directive/participative? (Relationship oriented) ↓	↕	↕	↕
Participative-subordinate centered (Task oriented)	Uncertain and complex	Autonomous and loose; members expect to participate in decisions	High need for independence High tolerance for ambiguity Much knowledge and information about the work

found to differentiate managers from engineers. "The results suggest that, relative to engineers, managers show a greater preference for acting upon and through other people, are more outspoken, socially oriented, confident, poised, and competitive, and they express enjoyment and comfort in interacting with others. Manager-trained engineers had similarities to both the engineer and manager groups scoring significantly higher on dominance (Do) than engineers and significantly higher on psychological mindedness (Py) than managers. These findings suggest that manager-engineers exhibit the same preference for leadership roles that managers do, but do not possess the same level of social poise nor enjoyment of human interaction. Also, the elevated Py suggests that the manager-engineers' style of management may be different than his non-engineering-trained colleague. He may base his management style to a greater degree upon intellectual insight into the needs and motives of people and less on the pleasure of interacting with them."[27]

A second research study by McClelland and Boyatzis[28] attempted to correlate results from the Thematic Apperception Test (TAT) with promotion to higher levels of management. A leadership motive pattern (LMP) was developed by the authors from several personality variables which were measured by content codes for stories written to pictures in a version of the TAT. The pattern and its theoretical explanation is presented below:

Personality Variable	Explanation
Moderately high need for power	Shows that the person is interested in influencing others
Low need for affiliation	Enables the manager to make difficult decisions without worrying unduly about being disliked
High activity inhibition	Person is likely to be concerned with maintaining organizational systems and following orderly procedure

The sample for this study consisted of 311 entry-level managers (all males) from American Telephone and Telegraph Company (AT&T) who were administered the TAT and then followed up 8 and 16 years later. At the 16-year point, the 246 managers who were still with the company were classified into technical (92) and non-technical (146) groups. Progress, measured by level of management attained in the company, was highly correlated with the LMP for non-technical managers but was not at all associated with success for the technical managers.

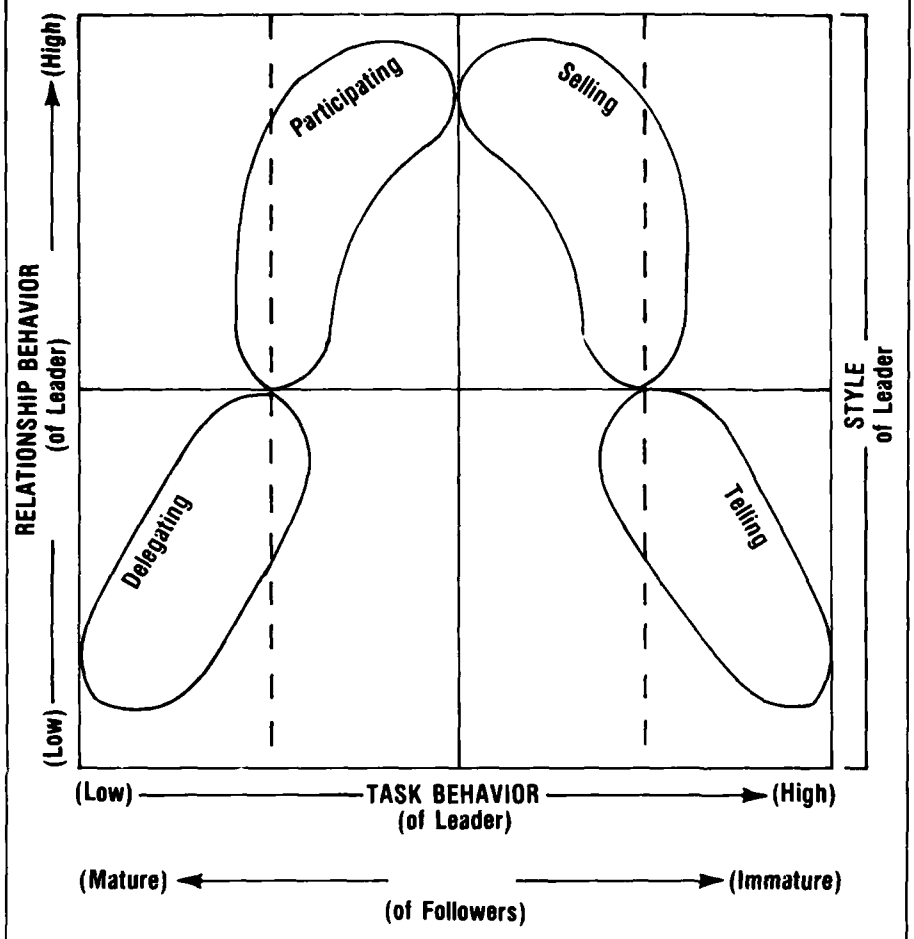
To answer the question of why such a sharp contrast occured in the above results for managers who have been with the same company for several years, I will turn to a recent report by Barefield[29] which included data from the assessment centers of this same company (AT&T). Table 4 contains the results of assessments made from 1956-1962, and Table 5 contains the 20-year follow-up data. Note that all three groups were accurately predicted within 3 percent. But the significant result is the much lower percentage of engineers that had reached middle management after 20 years. Additional investigation revealed that the more successful technical managers were rated higher than the less successful technical managers on oral communication skills (part of interpersonal skills in the Table 3 assessment).[30]

Moving from technical specialist to manager may not be an easy transition. It is not advantageous to stay in a technical area too long.

Reviews of Engineering Education

This theme of deficient oral communication and interpersonal skills also is evident in engineers' perceptions of themselves and their education from

Figure 2. Situational Leadership Theory (Hershey and Blanchard)[25]



interview data. For example, a recent study by Honeywell Corporation was summarized by Barefield as follows:

> The general consensus on the state of current engineering education in terms of concern for future management potential of engineers in that little to no attention is given to such topics as:
>
> —interpersonal group dynamics
> —interpersonal group skills
> —communication, including technical writing
> —resolving team conflicts
>
> Although more than 70 U.S. engineering schools now offer M.B.A. and M.S. degrees or business-oriented courses, their programs most often stress only the technical aspects of management and not the interpersonal ones.[33]

A second source was feedback from interviews of 500 practicing engineers from a major U.S. corporation who were interviewed by Dr. Robert B. Davis, Dean of the School of Engineering at the University of Missouri, Rolla. The interviews were conducted to provide information on how best to acquire and use computer hardware for engineering education. But, Dean Davis found other information from the interviews:

> One of the questions in the standard set he used concerned what was missing from their undergraduate education. The following three conclusions were almost universally expressed by the 500 engineers:
>
> —It is not advantageous to stay in a technical area too long. If you are to get ahead, you must go into management.
> —Those who have management potential are identified early, usually by the end of their second year on the job.
> —Those who are identified as having management potential have at least average technical skills and superior interpersonal skills.
>
> It was pointed out (that) almost all upward contact was made by short verbal and written messages; and the engineers believed that major decisions about their future were made on the basis of these communications.[34]

Finally, from a survey conducted by Louis Harris and Associates for the Institute of Electrical and Electronics Engineers (IEEE):

> Seven in ten respondents said the EE education is lacking in communication skills, and two-thirds said the same about human relations skills. These findings were confirmed independently of the survey by interviews with EEs who consistently stated their educations had these shortcomings....Several engineers said that engineers make bad managers because they are not adept at dealing with people, or "life's non-idealities," as one manager put it.[35]

DSMC Takes Action

With several sources documenting deficiencies in technical managers' interpersonal and oral communication skills, what can be done to correct these deficiencies? The Defense Systems Management College is particularly concerned with these findings since its student population consists of military officers and government civilians who are making the transition from functional specialties into program management. A survey of the last two Program Management Courses (PMCs) reveals that 66 percent (270 out of 440) have engineering and scientific undergraduate backgrounds. Similar data from our recent Program Managers' Workshops, consisting of students slated for key positions on major defense programs, show a higher figure of 78 percent (52 out of 67) with technical backgrounds.

The Defense Systems Management College recognizes the importance of interpersonal skill and effective communication in developing program managers. In the 20-week PMC, students are assigned to 6-member work

Table 4. AT&T Management Assessments (1956-1962) by College Major[31]

High (H) and Low (L) Scorers
(Sample size ranged from 68 to 96)

	Humanities and Social Sciences	Engineers	Business
Administrative Skills	H	L	H
Interpersonal Skills	H	L	H
Intellectual Ability			
Verbal	H	L	L
Quantitative	L	H	L
Advancement Potential	H	L	H
Have Middle Management Potential	46%	26%	31%

groups and given several team projects requiring cooperative effort. Other classes also stress communication skills, team building, conflict management, and working with different personality types. But more effort is required to bridge the gap between classroom knowledge and actual performance in the work environment. This gap is illustrated more clearly in the Competency Acquisition Model developed by McBer and Company and used in management training programs in both government and industry. The model, illustrated in Figure 3, consists of six steps designed to develop any given management skill in the work environment. The first three steps (awareness, knowledge, and evaluation) are the normal products of classroom instruction. But, as the model shows, these steps are insufficient to develop managerial skill unless they are followed by opportunities to adjust, practice, and get feedback on performance.

"Too often training programs attempt to 'teach the fundamentals' using lectures, readings, case discussions, films, and dynamic speakers to transmit knowledge to course participants. Unfortunately, it is usually not the lack of knowledge, but the inability to *use* knowledge that limits effective managerial behavior."[37] This statement was reinforced in an interview with Dr. Richard Boyatzis, McBer's President, who stated that, out of all the managerial jobs they studied in

Table 5. AT&T Progress in Management (Follow-up Data) by College Major[32]

(Sample size ranged from 40 to 68)

	Humanities — Social Science	Engineers	Business
Years to Reach 2nd Level**	4.0	5.4	3.9
Management Level at 8 Years**	2.6	2.2	2.4
Management Level at 20 Years	3.4	3.2	3.2
Percentage 4th Level or Higher at 20 Years	43%	23%	32%

**Group differences statistically significant at $p < .005$

both government and industry, in only one case was there a significant difference in the knowledge possessed by the top performers when compared to average performers in the same jobs.[38]

To structure opportunities to practice and receive feedback on managerial skills, DSMC has made some changes in the 20-week PMC. A series of management development lessons have been created with opportunities for self-assessment, practice, and goal setting on individual management skills. The Acquisition Management Laboratory has revised several of its Systems-X case studies to incorporate role-playing opportunities for groups of students. The College has investigated several existing role-playing organizational simulations that feature up to 20 individually tailored management roles. These simulations are designed to recreate the multiple problems and complex interactions that characterize the managerial environment. After studying the background information for their role, each manager is free to take whatever action he/she pleases (phone calls, memos, meetings, informal discussion, decisions, etc.) consistent with his/her normal management style. After the simulation, participants are given feedback not only on the problems they were able to solve but also on the effectiveness of each person's interpersonal and communications skills in the problem-solving process. Goal-setting sessions follow, but the final proof of management skill development can only come back in the students' own work environments. To make the transition more effective, considerable effort is still required at DSMC to integrate our knowledge-based core curriculum with more realistic opportunities for practice and application by the students.

DOD engineers and scientists need more interpersonal and communication skills development to improve success as acquisition managers.

Summary

As a group, engineers believe that moving into management will bring them higher salaries and higher levels of responsibility than continuing in their technical disciplines. Data from two major studies show that engineers do transition into management positions in ever-increasing numbers during their careers. Limited research has been done comparing engineers and managers, most without regard to the effectiveness of either group. Effectiveness studies that have been done are generally inconclusive about any unique characteristics of effective technical managers. The major exception is that technical managers score lower on interpersonal skills than non-technical managers, and that the more successful technical managers were rated higher on interpersonal skills than the less-successful technical managers. Also, engineers see themselves and their undergraduate curricula as markedly deficient in developing their human-relations and communication skills.

The implication of these findings for DSMC is that DOD engineers and scientists need more interpersonal skills

Figure 3. The Competency Acquisition Model[36]

Recognize the competency	"Awareness"
↓	
Understand the competency and relate it to performance	"Knowledge"
↓	
Self-assessment or instrumented feedback on the competency	"Evaluation"
↓	
Experiment with demonstration of the competency	"Adjustment/Change"
↓	
Practice using the competency and receive feedback	"Practice"
↓	
Apply the competency in job situations and in the context of other characteristics	"Application"

development to improve both their selection opportunity and success as acquisition managers. The Defense Systems Management College recognizes this problem and is taking action to solve it. In addition to existing classroom instruction, DSMC's management development week and use of role-playing case studies and management simulations promises to bridge the gap between awareness and successful application of these critical interpersonal and communication skills in the job environment.■

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Reshuffling at the Top

Reallocation of DOD Procurement Duties

Calvin Brown

On Nov. 19, 1985, William H. Taft IV, deputy secretary of defense (DEPSECDEF), assumed the dual roles of defense acquisition executive (DAE) and procurement executive (PE). In an internal Pentagon memorandum, Mr. Taft divested James P. Wade, Jr., assistant secretary of defense for acquisition and logistics (ASD(A&L)) of those roles, which were assigned July 25, 1985.

The same day, Mr. Taft issued revised versions of DOD Directive 5000.1, "Major Systems Acquisition"; DOD Instruction 5000.2, "Major Systems Acquisition Procedures"; DOD Directive 5128.1, "Assistant Secretary of Defense (Acquisition and Logistics)"; and DOD Directive 5129.1, "Under Secretary of Defense for Research and Engineering." Revisions include effects of changes made in the duties and responsibilities assigned to the DEPSECDEF, the undersecretary of defense for research and engineering (USDRE), and the ASD (A&L) in light of Mr. Taft's memo.

These changes came less than 1 year after creation of the position of ASD(A&L). In a January 29, 1985, Pentagon press release, Secretary of Defense Caspar W. Weinberger announced reorganization actions to streamline management of acquisition, logistics, and other key functions under his office. The reorganization would bring under a single executive, ASD(A&L), "the responsibility for managing the weapons system acquisition process, along with the supporting facilities, systems and other physical resources." Further, the ASD(A&L) would serve as the defense acquisition executive, and responsibilities for acquisition management and procurement policy were transferred from USDRE to ASD(A&L). The media adopted the title, "procurement czar," for the new position. Dr. Wade, previously principal deputy undersecretary of defense for research and engineering, was named on July 5, 1985, to be assistant secretary of defense for acquisition and logistics, and Dr. Donald H. Hicks was sworn in August 6, 1985, as undersecretary of defense for research and engineering.

What prompted the deputy defense secretary to make those significant changes in November 1985 and what are the effects of those changes?

Two questions arise. What prompted the deputy defense secretary to make those significant changes in November 1985 and what are the effects of those changes? Before reorganization in February 1985, the USDRE was DAE, chaired the Defense Systems Acquisition Review Council (DSARC) and exerted strong control over the procurement process. The reorganization, however, separated research and development from procurement by creating the new ASD (A&L), who reported directly to the secretary of defense, not to USDRE. In the aftermath, DSARC responsibilities were divided between USDRE and ASD (A&L). The motivation for these changes is unclear. However, significant responsibility did shift upward to the deputy secretary of defense.

To answer the second question, I selected excerpts from the recently changed DOD Directives 5000.1, 5128.1 and 5129.1 relating to responsibilities of the DEPSECDEF and the responsibilities/functional areas assigned to USDRE and ASD (A&L).

Responsibilities

1. The deputy secretary of defense is designated the defense acquisition executive and the procurement executive (DAE/PE). In this capacity the DEPSECDEF shall:

a. Be the principal advisor to the secretary of defense for the acquisition of defense systems and equipment.

b. Through the DSARC chair, ensure the management process, policies, and procedures for major systems acquisitions are integrated and unified.

c. Monitor and ensure DOD compliance with the policies and practices in "The Office of Federal Procurement Policy Act" (Public Law 98 - 191), OMB Circular A-109, DOD Directives 5000.1 and 5000.3, and DOD Instruction 5000.2.

2. The undersecretary of defense for research and engineering shall be responsible for policy, review, and acquisition strategy of all research, engineering development, technology, and test and evaluation of major systems and shall:

a. Serve as a permanent member and SSARC chair for milestone O, I, and II DSARC Reviews.

b. Monitor DOD Component procedures for analysis of mission areas.

c. Coordinate the review of Justification of Major System New Starts (JMSNS) in the Program Objectives Memorandum (POM) to determine whether major system new starts should be included in the Program Decision Memorandum (PDM).

d. Coordinate the interface of the acquisition process with the Planning, Programming, and Budgeting System (PPBS).

USDRE is also the principal staff assistant and advisor to the secretary of defense for DOD scientific and technical matters, basic and applied research, environmental sciences, the development of weapon systems and appropriate international agreements (DODD 5129.1) For each assigned functional area the USDRE shall:

e. Develop policies, conduct analyses, provide advice, make recommendations, issue guidance on DOD plans, programs and requirements determinations.

f. Review proposed resource programs, formulate budget estimates, recommend resource allocations and priorities, and monitor the implementation of approved programs.

g. Plan and recommend an optimum integrated program of research and development to meet the requirements of national military objectives and initiate projects to fill important gaps which may exist.

h. Promote coordination, cooperation, and mutual understanding of all matters related to assigned activities, both inside and outside of the Department of Defense, including oversight and policy formulation for international agreements on systems acquisition matters with North Atlantic Treaty Organization (NATO) allies and other friendly nations.

i. Serve as primary focal point and principal spokesman and serve on boards, committees, and other groups pertaining to assigned functional areas, and represent the secretary of defense on USDRE matters ouside the Department of Defense.

j. Exercise direction, authority and control over the Defense Advanced Research Projects Agency, the Defense Nuclear Agency, and the Defense Systems Management College.

3. The assistant secretary of defense (acquisition and logistics) shall be responsible for policy, review, and acquisition strategy for the production procurement of all major systems, and will be the major high official for policy on logistics, facility construction, energy, environment, and safety for new major systems throughout their life cycle and shall:

a. Serve as a permanent member and DSARC chair for Milestone III DSARC reviews.

b. Ensure that logistics planning is consistent with system hardware parameters, logistic policies, and readiness objectives.

c. Monitor DOD Component procedures for planning and providing post-production support to meet system readiness objectives.

d. Coordinate the interface of the acquisition process with the PPBS.

The ASD (A&L) is the principal staff assistant and advisor to the secretary of defense for management of DOD production procurement, development of procurement regulations, career management of the procurement work force, logistics, installations, associated support functions and other related matters (DODD 5028.1). For each assigned area the ASD(A&L) shall:

e. Develop policies, conduct analyses, provide advice, make recommendations and issue guidance on DOD plans and programs and requirements determination.

f. Promote coordination, cooperation, and mutual understanding about all matters related to assigned activities both inside and outside the DOD, including oversight and policy formulation for international logistics and military construction agreements and implementation of co-production agreements with NATO allies and other friendly nations.

g. Exercise direction, authority and control over the Defense Logisitics Agency and the Armed Forces Pest Management Board.

h. Provide policy guidance, goal-setting, and management supervision for the Logistics Systems Analysis Office, Defense Logistics Studies Information Exchange, *Defense Management Journal*, Defense Materiel Specifications and Standard Office, Product Engineering Service Office, Office of the Industrial Base Assessment, Defense Housing Management Systems Office, Defense Base Operations Analysis Office, and Weapon Support Improvement and Analysis Office.

Functional Areas

1. USDRE is responsible for the following functional areas:

a. Scientific and technical information, basic research, exploratory development and advanced technology development.

b. Review and evaluate submissions of specific mission needs to be fulfilled, relative priority assigned within DOD, and general magnitude of resources to be utilized.

c. Development and acquisition of weapon systems through full-scale engineering development to include product improvements and preplanned product improvements.

d. Design and engineering for suitability, producibility, reliability, maintainability, trainability, design-to-cost, configuration management, and materials conservation including life-cycle considerations.

e. Research and development for manufacturing technology.

f. Research interchange, co-development, and rationalization, standardization and interoperability with friendly and allied nations, including international and reciprocal memoranda of understanding (except logistics and military construction) agreements. Serves as the national armaments director and secretary of defense representative to the Four Power Conference.

g. Federally Funded Research and Development Center (FFRDC) oversight (except Logistics Management Institute) and policy.

2. ASD (A&L) is responsible for the following functional areas:

a. Maintenance and administration of the Federal Acquisition Regulation and the DOD supplement and other implementations thereto within DOD.

b. Weapon systems production procurement.

c. Contract policy and administration and contract pricing and finance.

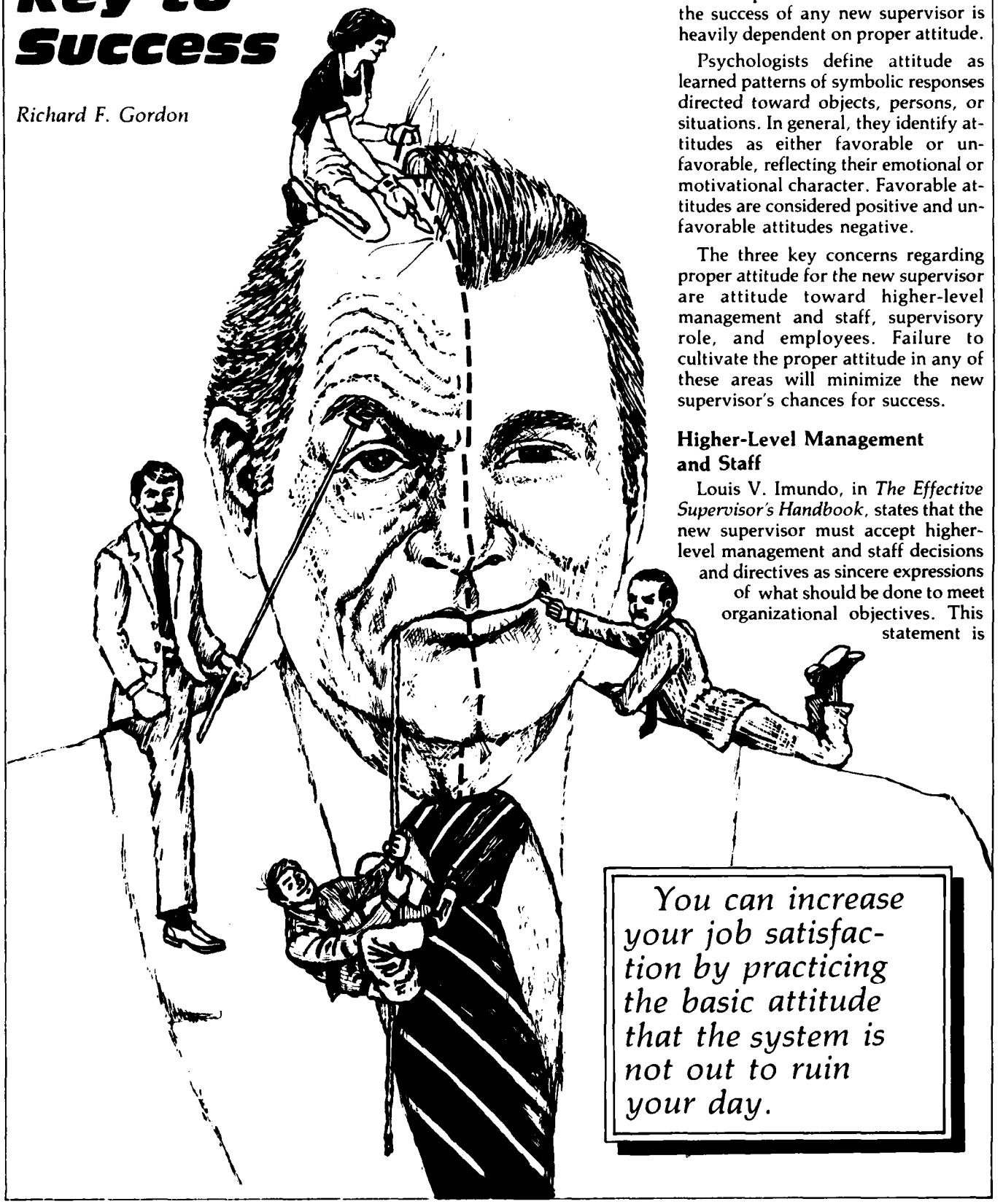
d. Development of DOD policy for contract studies and consultant services.

(See Reshuffling, page 53)

■*Mr. Brown is a professor of engineering management in the Research Directorate at DSMC.*

Attitude — Key to Success

Richard F. Gordon



What is the most important personal attribute that the new supervisor brings to the workplace? There is mutual agreement among experienced supervisors and educators that the success of any new supervisor is heavily dependent on proper attitude.

Psychologists define attitude as learned patterns of symbolic responses directed toward objects, persons, or situations. In general, they identify attitudes as either favorable or unfavorable, reflecting their emotional or motivational character. Favorable attitudes are considered positive and unfavorable attitudes negative.

The three key concerns regarding proper attitude for the new supervisor are attitude toward higher-level management and staff, supervisory role, and employees. Failure to cultivate the proper attitude in any of these areas will minimize the new supervisor's chances for success.

Higher-Level Management and Staff

Louis V. Imundo, in *The Effective Supervisor's Handbook*, states that the new supervisor must accept higher-level management and staff decisions and directives as sincere expressions of what should be done to meet organizational objectives. This statement is

You can increase your job satisfaction by practicing the basic attitude that the system is not out to ruin your day.

simplistic and easy to comply with in a stable work environment. However, most work environments are not stable and the only two constants are change and flexibility. New supervisors must recognize that the higher-level manager's priority perspective is in terms of the total system of operation, and priorities are set accordingly. Without a clear understanding of the need for these priorities, supervisors risk disapproval of their actions when deviating from the priorities established by higher-level managers.

Contrary to popular belief, the staff group's basic function is to provide support in their area of expertise. The new supervisor may view staff employees negatively, especially if the supervisor feels that staff decisions and directives are eroding his or her supervisory authority. A more positive initial approach is to view the staff group as a knowledge transfer resource base—someone the new supervisor can turn to for advice and consultation.

As a supervisor, you may have a legitimate difference of opinion regarding organizational policies and higher management and staff decisions. You have a legitimate right, as a supervisor, to ask for review of decisions and policy changes that directly or indirectly affect your organization or employees. These disagreements should be discussed privately with higher management or staff personnel to resolve the difference of opinion. A word of caution: Don't discuss your disagreement openly with your employees. As a supervisor you are part of the management team and, as such, you must be supportive of higher-level decisions.

Supervisory Role

Margaret Hennig and Anne Jardim, in *The Managerial Woman*, state that supervision typically involves responsiblity for routine, predictable and specific job performance by subordinates in an area of skills with which the supervisor is extremely familiar. Having the appropriate technical job skills is an acceptable requisite for assignment to a supervisory position. And yet, job skills alone will not ensure success.

Competent workers want to respect their supervisor. They expect the supervisor to be competent; they also expect the supervisor to be fair. Supervisors are leaders, and leaders are responsible for setting proper examples for others to follow. Discard age-old adages such as "Don't do as I do, do as I say"; or "Rank has privileges," which do not work with modern-day people. Therefore, the primary responsibility of the new supervisor in terms of attitude is to serve as a role model. As a leader, the examples you set and the attitude you exhibit affects the behavior of your subordinates; i.e., tardiness, absenteeism, job responsibilities, and timeliness in task accomplishment. Marginal performance by subordinates in these specific areas may be a mirror image of your attitude regarding their importance. Leading by example is still a good concept.

Another important attitude aspect is decision-making for controversial issues. This may be one of the more difficult aspects of the new supervisor's leadership role. A leader is a person others look to for direction, a person whose judgment is respected because it is usually sound. Controversial issues should be decided on the basis of facts and circumstances. Matters involving subordinates should be decided on merit and not interpersonal relationships.

One of the problems confronting new supervisors is their friendship with previous co-workers who now become their subordinates. Obviously, you do not want your friendships to hurt your performance or the performances of your friends; and yet, you cannot allow your friendships to interfere with your methods of operation. It is important to recognize that everyone you supervise must be treated with equal fairness. Intuition and personal feelings are poor substitutes for professional competence.

Another problem confronting new supervisors is conflict within their work group. You must realize that whenever a group of people work together, some degree of conflict is inevitable. There are many sources of conflict in an organization; i.e., people with different ideas about what should be done and how to do it. This type of conflict is closely related to the work itself; how it is laid out and the way in which the supervisor manages the work force. Three specitic examples of actions by a supervisor that may cause conflict are: one-way communication, with the supervisor making all of the decisions; unpredictability in the way work should be done; and, continual change in the way work is done.

A positive attitude on your part can help minimize the adverse effects of conflict. Lester R. Bittel, in *What Every Supervisor Should Know*, recommends that you should first be alert to its presence. Next, seek out its causes, and meet it head-on. His recommended approach to dealing with conflict involves four steps:

—Decide what it is that you wish to be accomplished. Nothing will be resolved unless you first make up your mind what the desired outcome should be.

—Call together the people who can best settle the issue. If the conflict is strictly between you and one subordinate, limit the confrontation to the two of you.

—Be ready to bargain, not hand out edicts. Conflicts are truly settled by negotiation. Zero in on your objective, which usually can be achieved in more than one way.

—Do not be distracted by personalities. While many people do not get along, most conflicts have a much more tangible basis. By keying in on your main objective, it tends to push personality conflicts into the background.

A positive attitude toward setting a good example, resolving controversial issues in a fair and equitable manner, and resolving conflict before it becomes a disruptive force will enhance your chances of success.

Employees

W. Earl Sasser, Jr., and Frank S. Leonard in *Let First Level Supervisors Do Their Job* say that supervisors probably have more influence on productivity, worker absenteeism, product quality, morale of work force, labor relations, and cost reduction than any other management group in the company. A simple extention of this statement would lead us to conclude that the supervisor's primary attitude toward employees is to try to create a work environment where subordinates willingly cooperate to meet organizational objectives and, in so doing, also serve their own personal needs. This work environment should allow

subordinates to express their feelings and concerns openly, without fear of intimidation or reprisal.

Workers today no longer accept supervisor authority at face value. New supervisors must earn the respect, trust, and confidence of their subordinates. Initially, you may get surface respect. In the long run it is what subordinates really think of you, not what they say to you, that matters and that affects how well they perform. A positive attitude toward being predictable, keeping your promises, and being fair will facilitate subordinate acceptance of you in your supervisory role.

Many management experts believe that most employee problems can be solved through job enrichment. As a new supervisor, you should try to cultivate a positive attitude toward job enrichment, which means deliberate upgrading of responsiblity, scope, and challenge. The job-design continuum starts on the low side with rotation and extention, then progresses to the high side with enlargement and enrichment. The continuum implies that there is greater variety, more responsibility, and increased opportunity for personal growth as one progresses toward the enrichment side of the scale. The continuum job terms can be defined as: rotation—periodically reassigning the worker to new tasks; extension —giving the worker additional duties requiring the same skill level; enlargement—making the worker's assignment a larger part of the total process; and enrichment —giving the worker full responsibility for an entire process.

Job enrichment often involves more participation by subordinates in decision-making, and responsibility for planning and inspection, as well as doing. Some of the roadblocks to job enrichment are supervisors who resist the apparent threat to their authority; employees who show little interest in taking on new jobs; and labor unions that see the program as a scheme by management to get more work done for less money. Job enrichment is still one of the most commonly suggested cures for employee alienation and job dissatistaction.

Supervisors who embrace job enrichment or encourage subordinate participation in the decision-making process are not abdicating their management responsibilities. You can be assured that higher-level management will ultimately hold you accountable for your work group's performance. Therefore, you can not abdicate your responsibility for subordinate performance. In effect, you must accept partial responsibility for the failures of all subordinates. This includes the failures of your problem employees as well as those of the high achievers and committed employees. A word of caution: In discussing employee failures or shortcomings with higher management, do not say that it was entirely the subordinate's fault and attempt to absolve yourself of any wrongdoing. By so doing, you imply that you either do not know how the work should be done or you are not exercising proper control over the work group's output products. The most appropriate safeguard against subordinate failures is a positive attitude toward details and control.

The purpose of disciplinary action is to rehabilitate rather than to punish.

In addition to accepting partial responsibility for subordinates' failures, you must support subordinates in situations where they are right. Employees respect a leader who will take a personal risk to stand up for them, especially in dealings with higher management and staff personnel. Subordinates remember how they were treated by the supervisor when they were under stress and trying to cope with problem work assignments. Your supportive attitude, especially during stressful times, will have a strong influence on developing an atmosphere of mutual trust. Mutual trust, in the long run, will enhance future subordinate cooperation and productivity.

New supervisors must recognize that subordinates have more control over their futures than higher management. Your promotability will be determined by how well you perform in your current supervisory assignment. You should recognize that many subordinates share your aspirations for promotions. They also want recognition for a task well done. Recognition, praise, raises, and promotions should not be given on a subjective basis. This approach is in conflict with the basic intent of any reward system, in that the recipient should be an appropriate role-model for other employees to emulate. Recognition and rewards should be based on an objective assessment of the subordinate's job responsibilites and accomplishments. A positive attitude toward a fair and equitable reward system will enhance your work group's job satisfaction and morale.

One of the most difficult situations confronting the new supervisor is the need to discipline subordinates. When a problem situation initially arises, keep in mind that ignoring it will not make it go away. The opposite is usually true; it gets worse. Your initial reaction may be to use traditional strategies; for example, get tough, put them on probation, or make them so miserable they will quit. This coercive approach is negative because all of the emphasis is on punishment. You will not have any long-term success by utilizing a coercive power base.

Louis V. Imundo, in *The Effective Supervisor's Handbook*, recommends a more positive approach. His basic premise for positive discipline is that the purpose of disciplinary action is to rehabilitate rather than punish. Positive discipline takes the form of support and reinforcement for approved actions. Corrective action for improper behavior should be supportive; there can be no vindication. Let the subordinates know that you approve of them as people, but discipline them for specific actions.

The key prerequisites for using a positive discipline approach are communication of rules, regulations, procedures, and job requirements to all employees. You, as a supervisor, must communicate to subordinates the kind of positive behavior expected of them. You should encourage subordinates to develop a sense of personal respon-

(See Attitude, page 53)

TEAMWORK

Staff Offices

Is "the Matrix" a Problem?

J. William Kerpelman

During my years of experience as a member or manager of Navy management staff offices, I have held innumerable discussions with key line and program management personnel indicating that many PMs view "the matrix" as a problem.

Though all of my direct experience has been in Naval Systems Commands, I expect this same view exists to some degree in other military services' acquisition organizations. Conversations among and with current DSMC Program Management Course students reaffirm this view. Students frequently identify "the staff offices" as a particular problem—often in a seemingly near-contemptuous tone. I would like to address relationships and some reasons for conflict among service (small "s") staffs and program managers from my perspective as the manager of Navy Systems Command service staff offices. In this discussion, I refer primarily to service staff offices such as personnel, financial, administrative, and management programs; that is, staffs that exist to provide expertise in their specialty and service to top management and to line and PM elements of the organization. In addition, I believe this discussion applies to what might be termed the advocacy staffs—those established to promote a specific ancillary program; examples are the older "ilities" offices and the more recently created competition and streamlining advocates. However, this discussion does not apply to line elements of the matrix that are integral parts of the life cycle; i.e., research, engineering, test, evaluation, and logistics support organizations.

Must This Conflict Occur?

Organization and management literature is replete with discussions of the line and staff organizations, and with the matrix organization. These discussions generally recognize the built-in potential for conflict among the program manager, the line, and staff elements of the organization that result from different orientations toward what is important. Must this conflict occur? I maintain that better understanding of both sides' goals and perceptions might help minimize conflict between PM and service staff offices. The end-result would be to achieve more smoothly the goal toward which major DOD program management efforts are directed—providing and supporting the world's best weapons systems for our military users.

Why do many program managers denigrate the staff offices of their larger organizations? After all, don't they exist to help the program manager do his job? Why, then, do service staffs often appear to be obstructionist naysayers to the PM? It may be helpful if PMs better understand the role of these staffs; similarly, service staff office personnel should better understand their optimum role as well as that of the PM.

The PM is oriented to getting the job done; i.e., developing and producing the system for which he is the responsible manager. He is under tremendous pressure to perform and deliver his system on time and on cost, while meeting performance requirements. Chances are he would not have been selected to be a program manager if he were not action oriented. In acquisition agencies, as in every organization, a "pecking order" develops. In the aerospace industry the design engineers may be at the top; in the garment industry, the fashion designer; in the department store business, the buyer. In the acquisition business, the program manager sometimes considers himself to be the "Brahmin" of the organization's system, and is single-minded in pursuit of program objectives. Therefore, the PM often cannot abide what he perceives to be interference or obstructionism from service staff office members.

A Dual Role

The service staffer, on the other hand, has a dual role that is oriented toward expertise in a particular specialty, many of which, by their very nature, are governed by substantial rules and regulations. The service staff specialist, if not properly indoctrinated by management, may view himself as only holding back profligate spending, overstaffing, overgrading of personnel, etc. This role, to some degree, is often one of the service staff specialist's designated responsibilities, and he may see the PM as a single-issue-driven person who deems himself above the law, caring little or nothing about rules and regulations (many of which are in place to follow executive or congressional direction, to implement legislation, and to serve interests of the taxpayer). The proper service staff organization role might be likened to the Roman god Janus, depicted with two faces placed back to back, thus enabling him to see in opposite directions simultaneously. One staff face always should be turned in the direction of providing service in his specialty to the PMs and other parts of the organization; while the other face is looking in the direction of serving top management's requirements for assuring that its policies are followed and that the regulatory framework is not ignored. Despite the aforementioned pressures on the PM to perform, he should recognize that top management must integrate and direct numerous PMs and other organizational elements' activities toward accomplishing command goals. Management often uses the service staff offices to assist in this aim. Recognizing these PM/staff differences in perspective can go a long way toward understanding and dealing with service conflict.

In identifying reasons for role conflict among program managers and service staffs, top-level management and senior staff office managers do not get off scot-free. They must recognize the potential that exists for friction and must inculcate a "service attitude" among staff specialists. Command

goals should be stated and understood by all members of the organization and must continually receive emphasis by management. Parochialism, tunnel vision, and self-serving career orientation must be guarded against on all sides, and the big picture must be recognized and considered in all of the service staff members' activities, as well as among PMs. A cavalier staff attitude of how many "gotchas" can be collected on PMs should not be tolerated. The staff specialist must fully understand his vital service role of facilitating the achievement of the PM's and the organization's goals.

Program managers should make an effort to understand the points of view of the service staff. In dealing with PM personnel over the years, I have experienced recurring actions on the parts of program managers that raise the hackles of servicing staff personnel.

Retreating Behind the Rule Book

First is what may be perceived as an overbearing attitude toward the staff personnel with whom the PM is dealing. This may rapidly deflect the service staff person's attention from the PM's problem and cause him or her to retreat behind the rule book. Study after study show that the majority of the work force perform better when they have meaningful work to do and are respected and recognized for their knowledge, performance and contribution to the organization's efforts. This applies to the service staff specialist as well as the program manager and his staff. The PM may judge the service staff's work to be pedestrian; he may find the PM office work of dealing daily with an important, tangible user end-product quite exciting and central to his command's goals. Even so, successful PMs understand there is a legitimate purpose for service staff organizations. A PM in a conference with a service staff specialist will find that recognizing the staffer's legitimate role and expertise can go a long way toward easier accomplishment of the PM's goals.

Second, PMs often think they must hide their real objectives when dealing with service staff specialists; after all, they are only policemen, aren't they? Based on my experience, I suggest it is better to be "up front" with the staff regarding the PM's objective than it is to hide it.

For example, when a position description is rewritten or a reorganization is proposed, the experienced service staff reviewer knows that frequently this may be a disguised attempt to promote, upgrade, or otherwise legitimately "take care" of some individual in the PM office, despite PM assurance that improved efficiency is the only goal. Staff specialists with even a modicum of a service attitude can be of more help to the PM if the latter provides an honest statement of his objective or the problem he is attempting to solve. Then, especially if he has been properly goal-oriented by his own management, the service staff member may willingly expedite accomplishment of the PM's goal.

Use Interpersonal Skills

In this article, I have attempted to present how things look from both the service staff and the PM sides of the organizational street. Surveys of successful programs have identified the manager's interpersonal skills as one of the most important characteristics in achieving program success. I suggest that if the PM exercises his best human relations and communication skills when interfacing with service staff office personnel, the support received by the PM might be substantially improved. Similarly, members of service staff organizations should meet PMs with an open mind and remain ever vigilant that their service face is not lost among the proliferating tangle of regulations from "above." Also, the PM should emphasize to service staff office management the importance of having staff personnel recognize and accept their service roles should the PM encounter an excessive red-tape, rule-book mentality among the staff. There is no doubt that service staffs and PMs can gain by pulling together within the regulatory framework to help field the system, given mutual understanding of each other's views and the assumption of proper perspectives by *both* staff and program management personnel. This can only lead to smoother organizational goal accomplishment and more job satisfaction for both the program management personnel and the service staffs. ■

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STATEMENT REQUIRED BY THE ACT OF AUGUST 12, 1970, SECTION 3685, TITLE 39, UNITED STATES CODE, SHOWING THE OWNERSHIP, MANAGEMENT, AND CIRCULATION OF

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Reshuffling

(Continued from page 47)

e. Construction, including construction funded by host nations under the NATO Infrastructure Program.

f. Repair, overhaul, modification installation, and preventive maintenance of weapon systems, equipment, standardization, and munitions.

Other functional areas of responsibility for USDRE and ASD (A&L) remain largely unchanged from those previously established.

There were a few other changes in the revised documents. The program initiation point was renamed Milestone O, "Mission Need Determination," but was not designated as a secretary of defense major milestone decision. The assistant secretary of defense (command, control, communications and intelligence) ASD (C^3I) was named as a DSARC member for DSARC reviews concerning C^3I systems. In what may be a point of confusion, DOD Directive 5000.1 consistently refers to "Assistant Secretary of Defense (Force, Manpower and Programs)" rather than "Assistant Secretary of Defense (Force Management and Personnel.)"

Conclusion

There are three primary effects of the changes implemented Nov. 19, 1985, by Deputy Secretary Taft. First, the defense acquisition executive procurement executive was elevated from the assistant-secretary level to the deputy-secretary level. This provides an authority to referee possible conflicts between USDRE and ASD (A&L) before they reach Secretary Weinberger, as well as a single high-level official to speak to the Congress on all DOD acquisition and procurement issues. Second, the position of USDRE, which was significantly reduced by the January reorganization, has been increased by these changes. Nonetheless, the ASD (A&L) retains significant responsibilities, including purview of the Federal Acquisition Regulation and its DOD supplement—a source of significant influence in the defense procurement community.■

Attitude

(Continued from page 50)

sibility and self-discipline. When subordinates understand what is expected of them, they know the limits of acceptable behavior. A positive attitude toward discipline, by the supervisor, can reinforce subordinates' sense of security. If the positive discipline approach does not work, you can always fall back on the traditional approach.

In conclusion, your success as a supervisor will be heavily dependent on proper attitude. Your attitude toward higher management and staff decisions should be supportive. You must serve as a positive role model, be fair when dealing with controversial issues, and resolve conflict before it becomes disruptive. In dealings with subordinates be predictable and fair. Be supportive of job enrichment and subordinate participation in decision-making. Do not try to absolve yourself entirely for subordinates' failures, but do give recognition for a job well done. Try to use disciplinary actions to rehabilitate rather than punish. A positive attitude can be contagious, especially if it is sustained over a period of time. With a positive attitude you may end up being accused of managing a breeding ground for future supervisory talent.■

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Automation Speeds Camouflage Design

The Army Troop Support Command's Belvoir Research and Development Center here has let the first increment of a multiyear contract to establish the Army's first automated camouflage pattern generation facility.

The $1 million dollar award to Mandex, Inc., Vienna, Va., covers the procurement and installation of computer-aided design equipment in a contractor facility, training operators to design camouflage patterns, and initiating production.

The new facility will be used to design the three-color camouflage pattern now replacing the standard four-color on all Army tactical and mobility ground equipment. Its computer-generated patterns are expected to be more precise in the ratio of black, green and brown shapes, and cost less than the current hand design. Estimates are that computerization will cut five weeks of painstaking manual drawing to less than a week of automated design.

In operation, the computer system will employ CAMOGEN, a special software program developed for the Center by BDM Corp., to present a three-dimensional view of a piece of equipment from the manufacturer's blueprint. Seeds of color automatically planted on the image, following stored camouflage pattern criteria will then grow in proper ratio to camouflage the entire item. After regions of color are set, the computer draws boundaries around each to mark the color location. The pattern is then printed at any designed angle.■

Armaments

(Continued from page 27)

what has been described here will succeed in revitalizing the organization. Certainly there are many more critical factors involved than the plan itself—no matter how good. All the right words have been said. The ARDC plan has been lauded as a fine example of comprehensive planning by those leaders in AMC, TRADOC, and the Army staff to whom we presented it. What remains now is determined, disciplined execution and adaptation as necessary.

We hope that some of the ideas here presented may be of use to other agencies.■

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Reflections

(Continued from page 36)

Saturday or Sunday. I prefer to work late during the week and leave most of my weekends free. There's homework: phone calls, paperwork, catching up on what's going on in the rest of my service. I travel a lot on my own time. So, it adds up to about 60-70 hours per week. I have a harder time delegating because I find I must stay on top of everything. Am I my own worst case micromanager? I hope not, but I do know I'm working longer, not smarter. So's my staff. Lately, though, I've eased up on them, letting them work half days.

Q: Half days? What's this?

COLONEL: Twelve hours! Besides, I've gained too much weight. As I said earlier, 40 percent of my time is consumed with briefings and processing information requests. Dealing with contractors takes up 30 percent, admin and personnel about 10 percent, and managing all other aspects of the program the remaining 20 percent.

Q: What makes you stay in this business? Would you rather have an operational command somewhere?

COLONEL: Talk about a challenge? Friend, this is it, especially in peacetime. I'm a professional in a business where professionalism must prevail. The ultimate stakes are too high for less. Like every good soldier, sailor, airman, or marine, being a pro is what I want people to think of me. To be a good PM, I believe you must have the legs of Walter Payton to hurdle the tons of obstacles in your path, the stamina of Bill Rodgers to stay the 12 months of preparation for going to DSARC, the determination and perseverance of the Kansas City Royals, the agility of Mary Lou Retton and the organizational ability of Red Auerbach. I aspire to being able to fit that mold. Program management is a lot like law enforcement. You take the risks because you are willing, because you know what this means to your country. Someone has to do it. Policemen and PMs share one thing in common: We're shot at a lot. The difference is they're supposed to duck, but we can't. They're a moving target. We have to stand and take the hits. I've learned to handle it, because I have pride and confidence in what I am doing.

Q: You've given me quite an insight into what makes up a week in the life of a program manager, some of which is not comforting. Having gotten this off your chest, will you please step back for another look?

COLONEL: You're right. I had a lot to pour out on you. I have some suggestions on how things can get better. They are generalities, perhaps, but I feel strongly. First, I would signal a truce between those who are working the system and those who are beating up on it. A truce meaning holding it right there, a freeze-legislation, self-serving defenses of the system, apologizing for past sins, all of it. Challenge those in higher authority to exhibit true, gritty leadership. Take inventory. What's working, and what's not? Breathe deeply. Find the leaders and put them in place. Sit down and work things out. Educate those who need it. Encourage those who must produce the weapons. Motivate us all. Then lead. We out in the trenches will do our very best to serve the American people.■

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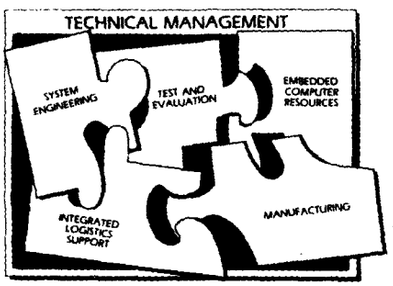

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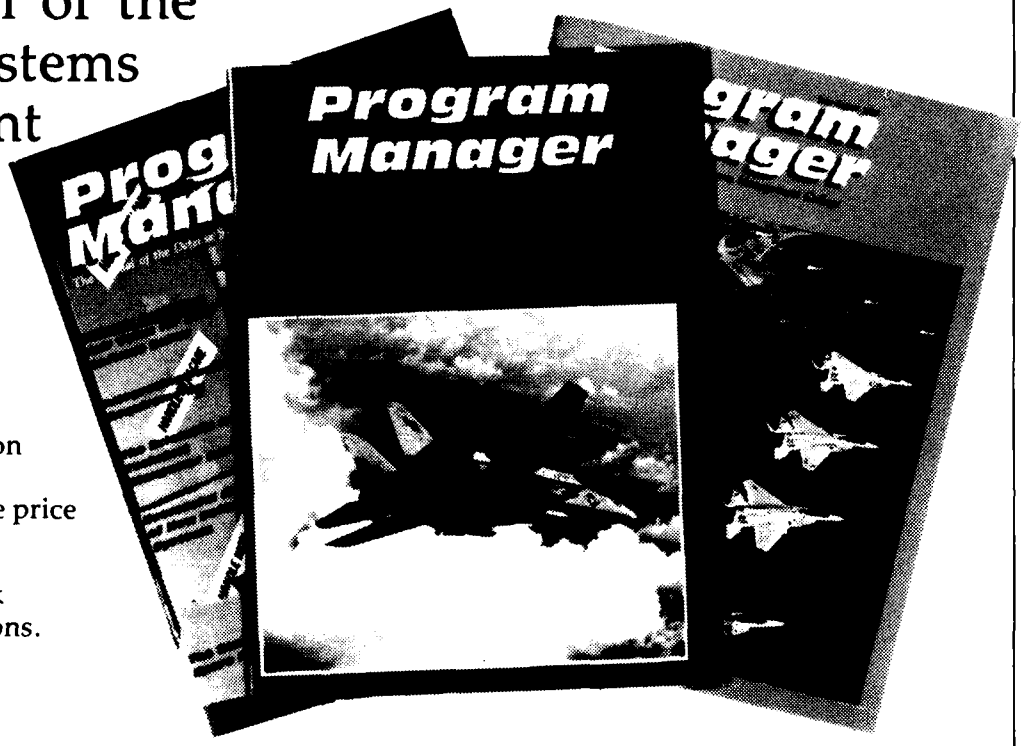

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